11-5895-915-34

ARMY
NAVY
AIR FORCE

TM 11–5895–915–34
NAVELEX 0967–LP–546–6480
TO 31R5–2G–122

DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL

SERVO AND CONTROL EQUIPMENT
Including:

CONTROL, ANTENNA C–9402/G; (NSN 5895–00–257–8168)
INDICATOR, ANTENNA, POSITION-STATUS ID–1912/G;
(NSN 5895–00–251–8071)
POWER SUPPLY ASSEMBLY PP–6959/G; (NSN 5895–00–251–8106)
CONTROL, DIRECT CURRENT C–9849/FSC; (NSN 5895–01–020–2825)
DRIVE ASSEMBLY, ELECTROMECHANICAL, ANTENNA TG–232/FSC;
(NSN 5895–01–007–9402)
SYNCHRO, ANTENNA SN–498/FSC; (NSN 5990–01–007–9483)
SYNCHRO, ANTENNA SN–482/FSC; (NSN 5895–00–237–2453)
CONTROL-INDICATOR ID–1936/G; (NSN 5895–00–241–9369)
FOR
SATELLITE COMMUNICATION TERMINALS
AN/FSC–78(V) AND AN/FSC–79.

This copy is a reprint which includes current pages from Change 1.

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE

6 SEPTEMBER 1978

D101.11:

READEX FICHE best copy available pages tightly bound

WARNING

When required to perform tests or repairs within direct current control HTA–9 cabinet, use extreme care to avoid injury or death from high voltages (277/480 V ac).

WARNING

CONTACTORS circuit breaker HTA–9A1CB2 controls application of the 277/480 V ac, 3-phase input to the scr assemblies. Do not perform any maintenance inside the cabinet with CONTACTORS circuit breaker CB2 set to ON.

WARNING

Use extreme care when tightening clamp screws and adjusting synchros. 120 V ac is exposed on pins A and B of J1, FL1 output pins 3 and 4, and T2 primary pins 4 and 5.

WARNING

120 V ac is present in power supply control HTA–9A1. Serious injury or death may result if normal precautions are not observed. Front panel circuit breakers do not completely isolate the 120 V ac; this voltage still exists as a potential hazard at the circuit breaker input terminals. Do not take chances.

WARNING

Stow pin control/minor fault summary panel HTA–8A24 contains 120 V ac. Use care when performing tests with front panel open, to prevent injury or death.

WARNING

When performing maintenance on or around magnetic contactors HTA–9K1, 9K2, make sure that ac input to applicable electronic control amplifier is turned off at ac distribution Box HTA–8A26. 277/480 V ac, 3-phase power is otherwise present at magnetic contactor HTA–9K1, 9K2 terminals.

WARNING

Do not attempt to remove any power inductor HTA–9L1 through 9L4 with power inputs connected. Hazardous voltages (277/480 V ac and 240 V dc) are present inside the direct current control cabinet.

WARNING

To prevent possible injury to personnel and damage to equipment, removal and replacement of power inductors HTA–9L1 through 9L4 should be performed only by personnel familiar with handling heavy equipment.

WARNING

Antenna drive assembly power must be turned off prior to performing maintenance involving the dc tachometer-generator or electric disk brake, to prevent serious injury or death from contact with 120/208 V ac.

WARNING

Antenna drive assembly power must be turned off prior to replacing the motor blower to prevent serious injury or death from contact with 120/208 V ac.

WARNING

Do not allow antenna to be moved while a synchro is removed. Loose cables and yoke movement without positional reference could cause injury.

WARNING

Up to 105 volts ac is present in the data module, between synchro contacts. Use caution when performing maintenance inside the unit.

WARNING

Elevation data module limit switch alignment requires that the antenna be moved about the elevation axis. Additionally, the transmitter down limiting function is unreliable when the limit switch is being aligned. Extreme hazardous conditions from rf radiation exist if the low elevation cutoff limit switch segment (E) is not functioning properly. Advise appropriate personnel prior to commencing the alignment so they may take the necessary precautions.

WARNING

When working aloft, at least two men equipped with safety belts and safety lines are required to implement this removal and replacement procedure and to prevent serious injury or death resulting from accidental fall. All tools carried aloft must have safety lines attached to prevent personnel injury due to falling tools.

WARNING

Use extreme care when performing maintenance inside the housing cabinet direct current control HTA–9 with the door interlock switch in the override position. Very high ac voltages (277/480 V ac) are present which could cause injury or death.

TM 11-5895-915-34
NAVELEX 0967-LP-546-6481
TO 31R5-2G-122
C 1

CHANGE }
No. 1 }

DEPARTMENTS OF THE ARMY,
THE NAVY, AND THE AIR FORCE
WASHINGTON, DC *28 May 1984*

Direct Support and General Support
Maintenance Manual
SERVO AND CONTROL EQUIPMENT
INCLUDING

CONTROL, ANTENNA C-9402/G; (NSN 5895-00-257-8168)
INDICATOR, ANTENNA, POSITION-STATUS ID-1912/G;
(NSN 5895-00-251-8071)
POWER SUPPLY ASSEMBLY PP-6959/G; (NSN 5895-00-251-8106)
CONTROL, DIRECT CURRENT C-9849/FSC; (NSN 5895-01-020-2825)
DRIVE ASSEMBLY, ELECTROMECHANICAL, ANTENNA TG-232/FSC;
(NSN 5895-01-007-9402)
SYNCHRO, ANTENNA SN-498/FSC; (NSN 5990-01-007-9483)
SYNCHRO, ANTENNA SN-482/FSC; (NSN 5895-00-237-2453)
CONTROL-INDICATOR ID-1936/G; (NSN 5895-00-241-9369)

FOR

SATELLITE COMMUNICATION TERMINALS
AN/FSC-78(V), AN/FSC-79 AND AN/GSC-39(V)

TM 11-5895-915-34/NAVELEX 0967-LP-546-6480/TO 31R5-2G-122, 6 September 1978, is changed as follows:

1. The title of the manual is changed to read as shown above.
2. New or revised material is indicated by a vertical bar in the margin. Where an entire chapter, section, or illustration is added or revised, the vertical bar is placed opposite the identification number and title.
3. Remove old pages and insert new pages as follows:

Remove pages	*Insert pages*
i through v	i through v
1-1 and 1-2	1-1 and 1-2
2-23 and 2-24	2-23 and 2-24
3-63 and 3-64	3-63 and 3-64
3-95 through3-98	3-95 through 3-98
3-125 and 3-126	3-125 and 3-126
A-5/(A-6 blank)	A-5/(A-6 blank)
FO-9 (sheet 4 of 5)	FO-9 (sheet 4 of 5)
FO-10	FO-10
FO-12 (sheet 1 of 4)	FO-12 (sheet 1 of 4)
FO-12 (sheet 4 of 4)	FO-12 (sheet 4 of 4)
FO-16 (sheet 1 of 2)	FO-16 (sheet 1 of 2)
FO-26	FO-26
FO-27	FO-27

4. File this change sheet in front of the publication.

By Order of the Secretaries of the Army, the Navy and the Air Force:

JOHN A. WICKMAN JR.
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

G. B. SCHICK, JR.
Rear Admiral, United States Navy
Commander, Naval Electronic
Systems Command

Official:

JAMES P. MULLINS
General, USAF, Commander, Air Force
Logistics Command

CHARLES A. GABRIEL
General, USAF
Chief of Staff

DISTRIBUTION:

To be distributed in accordance with DA Form 12-51A, Direct and General Support Maintenance requirements for AN/FSC-78; AN/FSC-79 and AN/GSC-39(V) 1.

TECHNICAL MANUAL
No. 11-5895-915-34
NAVELEX 0967-LP-546-6480
TECHNICAL ORDER
TO 31R5-2G-122

DEPARTMENTS OF THE ARMY,
THE NAVY, AND THE AIR FORCE

WASHINGTON, DC, *6 September 1978*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL
SERVO AND CONTROL EQUIPMENT
INCLUDING
CONTROL, ANTENNA C-9402/G; (NSN 5895-00-257-8168)
INDICATOR, ANTENNA, POSITION-STATUS ID-1912/G; (NSN 5895-00-251-8071)
POWER SUPPLY ASSEMBLY PP-6959/G; (NSN 5895-00-251-8106)
CONTROL, DIRECT CURRENT C-9849/FSC; (NSN 5895-01-020-2825)
DRIVE ASSEMBLY, ELECTROMECHANICAL, ANTENNA TG-232/FSC; (NSN 5895-01-007-9402)
SYNCHRO, ANTENNA SN-498/FSC; (NSN 5990-01-007-9483)
SYNCHRO, ANTENNA SN-482/FSC; (NSN 5895-00-237-2453)
CONTROL-INDICATOR ID-1936/G; (NSN 5895-00-241-9369)
FOR
SATELLITE COMMUNICATION TERMINALS
AN/FSC-78(V), AN/FSC-79, AND AN/GSC-39 (V)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letters, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703.

For Air Force, submit AFTO Form 22 (Technical Order System Publication Improvement Report and Reply) in accordance with paragraph 6-5, Section VI, T.O. 00-5-1. Forward direct to prime ALC/MST.

For Navy, mail comments to the Commander, Naval Electronics Systems, Command, ATTN: ELEX 8122, Washington, DC 20360.

In either case, a reply will furnished direct to you.

TABLE OF CONTENTS

			Paragraph	*Page*
APTER	1.	INTRODUCTION		
ection	I.	GENERAL	1-1	1-1
	II.	DESCRIPTION AND DATA	1-5	1-1
APTER	2.	FUNCTIONS OF EQUIPMENT		
ction	I.	FUNCTIONAL ANALYSIS OF SERVO AND CONTROL EQUIPMENT GROUP	2-1	2-1
	II.	CIRCUIT ANALYSIS OF ANTENNA CONTROL PANEL 14A8	2-9	2-12
	III.	CIRCUIT ANALYSIS OF ANTENNA POSITION AND STATUS PANEL 14A7	2-11	2-16
	IV.	CIRCUIT ANALYSIS OF SERVO POWER SUPPLY ASSEMBLY 14A9	2-15	2-21

			Paragraph	Page
	V.	CIRCUIT ANALYSIS OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24	2-18	2-2
	VI.	CIRCUIT ANALYSIS OF DIRECT CURRENT CONTROL HTA-9	2-24	2-2
	VII.	CIRCUIT ANALYSIS OF ANTENNA ANCILLARY GROUP HTA-12	2-28	2-3
	VIII.	CIRCUIT ANALYSIS OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 aND HTA-6A6A1	2-30	2-37
	IX.	CIRCUIT ANALYSIS OF PERSONNEL AND EQUIPMENT SAFETY CONTROLS	2-33	2-39
CHAPTER	3.	DIRECT SUPPORT MAINTENANCE INSTRUCTIONS		
Section	I.	GENERAL	3-1	3-1
	II.	TROUBLESHOOTING OF SERVO AND CONTROL EQUIPMENT GROUP	3-5	3-4
	III.	TROUBLESHOOTING OF ANTENNA CONTROL PANEL 14A8	3-10	3-7
	IV.	TROUBLESHOOTING OF ANTENNA POSITION AND STATUS PANEL 14A7	3-16	3-22
	V.	TROUBLESHOOTING OF SERVO POWER SUPPLY ASSEMBLY 14A9	3-21	3-33
	VI.	TROUBLESHOOTING OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24	3-27	3-58
	VII.	TROUBLESHOOTING OF DIRECT CURRENT CONTROL HTA-9	3-32	3-65
	VIII.	TROUBLESHOOTING OF ANTENNA ANCILLARY GROUP HTA-12	3-39	3-118
	IX.	TROUBLESHOOTING OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 AND HTA-6A6A1	3-44	3-124
	X.	TROUBLESHOOTING OF ANTENNA SAFETY INTERLOCK GROUP	3-49	3-130
	XI.	MAINTENANCE OF ANTENNA CONTROL PANEL 14A8	3-54	3-134
	XII.	MAINTENANCE OF ANTENNA POSITION AND STATUS PANEL 14A7	3-60	3-138
	XIII.	MAINTENANCE OF SERVO POWER SUPPLY ASSEMBLY 14A9	3-65	3-140
	XIV.	MAINTENANCE OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24	3-77	3-148
	XV.	MAINTENANCE OF DIRECT CURRENT CONTROL HTA-9	3-85	3-150
	XVI.	MAINTENANCE OF ANTENNA ANCILLARY GROUP HTA-12	3-99	3-169
	XVII.	MAINTENANCE OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 AND HTA-6A6A1	3-105	3-174
	XVIII.	MAINTENANCE OF ANTENNA SAFETY INTERLOCK GROUP COMPONENTS	3-113	3-182
	XIX.	TESTING OF SERVO AND CONTROL EQUIPMENT GROUP	3-118	3-183
	XX.	TESTING OF ANTENNA CONTROL PANEL 14A8	3-123	3-186
	XXI.	TESTING OF INSTRUMENT SERVO ASSEMBLY 14A8A1, A8A2	3-125	3-187
	XXII.	TESTING OF ANTENNA POSITION AND STATUS PANEL 14A7	3-130	3-189
	XXIII.	TESTING OF SERVO POWER SUPPLY ASSEMBLY 14A9	3-132	3-189
	XXIV.	TESTING OF +15 VDC AND -15 VDC POWER SUPPLY 14A9PS2, A9PS3	3-134	3-189
	XXV.	TESTING OF +5 VDC POWER SUPPLY 14A9PS4	3-139	3-192
	XXVI.	TESTING OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24	3-144	3-193
	XXVII.	TESTING OF DIRECT CURRENT CONTROL HTA-9	3-146	3-193
	XXVIII.	TESTING OF ELECTRONIC CONTROL AMPLIFIER HTA-9A2, 9A3	3-148	3-194
	XXIX.	TESTING OF POWER SUPPLY CONTROL HTA-9A1	3-153	3-197
	XXX.	TESTING OF +5 VDC POWER SUPPLY HTA-9A1PS1	3-158	3-199
	XXXI.	TESTING OF DUAL 15 VDC POWER SUPPLY HTA-9A1PS2	3-163	3-203
	XXXII.	TESTING OF +15 VDC GATE POWER SUPPLY HTA-9A1PS3	3-168	3-206
	XXXIII.	TESTING OF ANTENNA ANCILLARY GROUP HTA-12	3-173	3-209
	XXXIV.	TESTING OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 AND HTA-6A6A1	3-175	3-209
	XXXV.	TESTING OF ANTENNA SAFETY INTERLOCK GROUP	3-177	3-209
CHAPTER	4.	GENERAL SUPPORT MAINTENANCE INSTRUCTIONS		
Section	I.	GENERAL	4-1	4-1
	II.	MAINTENANCE OF INSTRUMENT SERVO ASSEMBLIES 14A8A1 AND 14A8A2	4-3	4-2
APPENDIX				A-1
GLOSSARY				GLOSSARY 1
INDEX				INDEX 1

List of Illustrations

Figure	Title	Page
1-1	Antenna control panel 14A8	1-3
1-2	Antenna position and status panel 14A7	1-5

Figure	Title	Page
1-3	Servo power supply assemb[illegible]A9	1-6
1-4	Stow pin control/minor fault summary panel HTA-8A24 (2 sheets)	1-7
1-5	Direct current control HTA-9 (3 sheets)	1-9
1-6	Azimuth/elevation drive motor assembly 1 and 2 HTA-12A1 through 12A4	1-13
1-7	Azimuth cable wrap and data module assembly HTA-8A7 (2 sheets)	1-14
1-8	Elevation synchro assembly HTA-6A6	1-16
1-9	Antenna safe switch HTA-4A7, 6A9, 8A10, 8A27	1-17
1-10	Reflector door switch HTA-2A1S1	1-29
2-1	Servo control, functional block diagram	2-2
2-2	Major faults, functional block diagram	2-3
2-3	Stow control and minor faults summary circuits, functional block diagram	2-5
2-4	Power distribution diagram	2-7
2-5	Instrument servo assembly 14A8A1, A8A2, servo gear train	2-15
2-6	Electronic control amplifier HTA-9A2, 9A3 local control circuits, simplified schematic diagram	2-26
2-7	Scr assembly HTA-9A2A2 through 9A2A7 and HTA-9A3A3 through 9A3A7, schematic diagram	2-30
2-8	Azimuth/elevation drive motor assembly 1 and 2, HTA-12A1 through 12A4, schematic diagram	2-36
2-9	Azimuth/elevation data modules HTA-8A7A1 and HTA-6A6A1 (typical), schematic diagram	2-38
2-10	Antenna safety interlocks, simplified schematic diagram	2-40
3-1	Servo and control equipment group troubleshooting interface block diagram	3-6
3-2	Antenna control panel 14A8, troubleshooting, test setup diagram	3-13
3-3	Antenna control panel 14A8, parts location (2 sheets)	3-14
3-4	Instrument servo assembly 14A8A1, A8A2, test setup diagram	3-16
3-5	Instrument servo assembly 14A8A1, A8A2, parts location (5 sheets)	3-17
3-6	Antenna position and status panel 14A7, troubleshooting, test setup diagram	3-29
3-7	Antenna position and status panel 14A7, parts location (3 sheets)	3-30
3-8	Servo power supply assembly 14A9, troubleshooting, test setup diagram	3-41
3-9	Servo power supply assembly 14A9, parts location (3 sheets)	3-42
3-10	Power supply 14A9PS2, A9PS3, A9PS4, troubleshooting and voltage adjustment, test setup diagram	3-45
3-11	+15 Vdc and −15 Vdc power supply 14A9PS2, A9PS3, parts location (6 sheets)	3-46
3-12	+15 Vdc power supply 14A9FS4, parts location (6 sheets)	3-52
3-13	Stow pin control/minor fault summary panel HTA-8A24, troubleshooting, test setup diagram	3-61
3-14	Stow pin control/minor fault summary panel HTA-8A24, parts location (3 sheets)	3-62
3-15	LED indicator locations on circuit card assembly HTA-9A2A1, 9A3A1	3-66
3-16	Direct current control HTA-9, troubleshooting, test setup diagram	3-67
3-17	Test point locations on circuit card assembly HTA-9A2A1, 9A3A1	3-68
3-18	Direct current control HTA-9, parts location (2 sheets)	3-69
3-19	Electronic control amplifier HTA-9A2, 9A3, troubleshooting, test setup diagram	3-79
3-20	Electronic control amplifier HTA-9A2, 9A3, parts location (3 sheets)	3-80
3-21	Power supply control HTA-9A1, troubleshooting, test setup diagram	3-83
3-22	Power supply control HTA-9A1, parts location (3 sheets)	3-95
3-23	+5 Vdc power supply HTA-9A1PS1, troubleshooting and voltage adjustment, test setup diagram	3-98
3-24	+5 Vdc power supply HTA-9A1PS1, parts location (4 sheets)	3-99
3-25	Dual 15 Vdc power supply HTA-9A1PS2, troubleshooting and voltage adjustment, test setup diagram	3-103
3-26	Dual 15 Vdc power supply HTA-9A1PS2, parts location (5 sheets)	3-104
3-27	+15 Vdc gate power supply HTA-9A1PS3, troubleshooting and voltage adjustment, test setup diagram	3-109
3-28	+15 Vdc gate power supply HTA-9A1PS3, parts location (6 sheets)	3-112
3-29	Drive motor assembly HTA-12A1, 12A2, 12A3, 12A4, troubleshooting test setup diagram	3-121
3-30	Drive motor assembly HTA-12A1, 12A2, 12A3, 12A4, parts location (2 sheets)	3-122
3-31	Az/el data module HTA-6A6A1, 8A7A1, troubleshooting, test setup diagram	3-127
3-32	Az/el module HTA-6A6A1, 8A7A1, parts location (2 sheets)	3-128
3-33	Antenna safety interlock group, troubleshooting, test setup diagram	3-132
3-34	Antenna safe switch HTA-4A7, 6A9, 8A10, 8A27, parts location	3-133
3-35	Indicator switch, replacement details	3-135
3-36	Power supplies 14A9PS2, A9PS3, A9PS4, overcurrent adjustment and performance test, test setup diagram	3-145
3-37	Power supply HTA-9A1PS1, 9A1PS3, overcurrent adjustment and performance test, test setup diagram	3-160
3-38	Electronic control amplifier HTA-9A2, 9A3 adjustments, component locations on circuit card assembly A1	3-165
3-39	Electronic control amplifier HTA-9A2, 9A3 adjustments, test setup diagram	3-166
3-40	Electric disk brake HTA-12A1A1, 12A2A1, 12A3A1, 12A4A1, exploded view	3-173
3-41	Electronic control amplifier HTA-9A2, 9A3, performance test, test setup diagram (2 sheets)	3-195
3-42	Power supply HTA-9A1PS2, performance test, test setup diagram	3-201
4-1	Instrument servo assembly 14A8A1, A8A2, parts location	4-3
4-2	Instrument servo assembly 14A8A1, A8A2 alignment, test setup diagram	4-5
4-3	Instrument servo assembly terminal board 14A8A1TB1, A8A2TB1, parts location	4-6
FO-1	Color code marking for MIL-STD resistors, inductors, and capacitors.	
FO-2	Servo and control equipment operating modes, functional block diagram	

Figure Title Page
FO-3 Servo and control equipment major fault detection and control, functional block diagram
FO-4 Servo and control equipment minor fault detection and control, functional block diagram
FO-5 Servo loop, functional block diagram
FO-6 Antenna control panel 14A8, schematic diagram
FO-7 Instrument servo assembly 14A8A1, A8A2, schematic diagram
FO-8 Antenna position and status panel 14A7 fault status and interlock circuits, simplified schematic diagram (2 sheets)
FO-9 Antenna position and status panel 14A7, schematic diagram (5 sheets)
FO-10 Mode logic circuit card assembly 14A7A1, logic-schematic diagram
FO-11 Servo analog circuit card assembly 14A7A2, A7A3, schematic diagram (2 sheets)
FO-12 Relay circuit card assembly 14A7A4 through 14A7A7, schematic diagram (4 sheets)
FO-13 Servo power supply assembly 14A9, schematic diagram
FO-14 15 V dc power supply 14A9PS2, A9PS3, schematic diagram
FO-15 5V dc power supply 14A9PS4, schematic diagram
FO-16 Stow pin control/minor fault summary panel HTA-8A24 schematic diagram (2 sheets)
FO-17 Direct current control HTA-9, block diagram
FO-18 Direct current control HTA-9, interconnection diagram
FO-19 Electronic control amplifier HTA-9A2, 9A3, functional schematic diagram
FO-20 Electronic control amplifier HTA-9A2, 9A3, schematic diagram (2 sheets)
FO-21 Circuit card assembly HTA-9A2A1, 9A3A1, schematic diagram (3 sheets)
FO-22 Electronic control amplifier HTA-9A2, 9A3-to-interfaces, operational interlocks, simplified schematic diagram
FO-23 Electronic control amplifier HTA-9A2, 9A3 drive power generation, simplified schematic diagram
FO-24 Electronic control amplifier HTA-9A2, 9A3, major fault detection circuits, simplified schematic diagram
FO-25 Electronic control amplifier HTA-9A2, 9A3, minor fault detection circuits, simplified schematic diagram
FO-26 Power supply control HTA-9A1, functional block diagram
FO-27 Power supply control HTA-9A1, schematic diagram
FO-28 +5 V dc power supply HTA-9A1PS2, schematic diagram
FO-29 Dual 15 V dc power supply HTA-9A1PS2, schematic diagram
FO-30 +15 V dc gate power supply HTA-9A1PS3, schematic diagram
FO-31 Servo and control equipment, block diagram
FO-32 Servo and control equipment group, troubleshooting flowchart (3 sheets)

List of Tables

Number Title Page
1-1 Servo and Control Equipment 1-2
1-2 Dimensions and Weights 1-18
1-3 Electrical Characteristics 1-19
1-4 Cross-Reference Index 1-27
2-1 Status Indicator and Fault Chain Relay Data 2-16
2-2 Circuit Card Assembly HTA-9A2A1, HTA-9A3A1 LED's 2-31
3-1 Tools and Test Equipment Required for Maintenance 3-1
3-2 Antenna Control Panel 14A8 Troubleshooting Procedure 3-8
3-3 Test Equipment Required for Instrument Servo Assembly 14A8A1, A8A2 Troubleshooting and Performance Test Procedures 3-9
3-4 Instrument Servo Assembly 14A8A1, A8A2 Troubleshooting Procedure 3-10
3-5 Test Equipment Required for Antenna Position and Status Panel 14A7 Troubleshooting Procedure 3-22
3-6 Antenna Position and Status Panel 14A7 Troubleshooting Procedure 3-25
3-7 Servo Power Supply Assembly 14A9 Troubleshooting Procedure 3-34
3-8 Test Equipment Required for Power Supply 14A9PS2, A9PS3, A9PS4 Troubleshooting Procedure 3-36
3-9 +15 VDC and −15 VDC Power Supply 14A9PS2, A9PS3 Troubleshooting Procedure 3-38
3-10 5 VDC Power Supply 14A9PS4 Troubleshooting Procedure 3-39
3-11 Stow Pin Control/Minor Fault Summary Panel HTA-8A24 Troubleshooting Procedure 3-59
3-12 Direct Current Control HTA-9 Troubleshooting Procedure 3-72
3-13 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure 3-73
3-14 Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure 3-74
3-15 Power Supply Control HTA-9A1 Troubleshooting Procedure 3-84
3-16 Test Equipment Required for 5 VDC Power Supply HTA-9A1PS1 Troubleshooting Procedure 3-85
3-17 5 VDC Power Supply HTA-9A1PS1 Troubleshooting Procedure 3-87
3-18 Test Equipment Required for Dual 15 VDC Power Supply HTA-9A1PS2 Troubleshooting Procedure 3-89
3-19 Dual 15 VDC Power Supply HTA-9A1PS2 (M Unit/Troubleshooting Procedure 3-90
3-20 Dual 15 VDC Power Supply HTA-9A1PS2 (S Unit) Troubleshooting Procedure 3-92
3-21 Test Equipment Required for 15 VDC Gate Power Supply HTA-9A1PS3 Troubleshooting Procedure 3-93

Number	Title	Page
3-22	15 VDC Power Supply HTA-9A1PS3 Troubleshooting Procedure	3-110
3-23	Az-El Drive Motor Assemblies HTA-12A1, 12A2, 12A3, 12A4 Troubleshooting Procedure	3-119
3-24	Az-El Data Module HTA-6A6A1, 8A7A1 Troubleshooting Procedure	3-125
3-25	Antenna Safety Interlock Group Troubleshooting Procedure	3-130
3-26	Test Equipment Required for 15 VDC, −15 VDC, and 5 VDC Power Supplies 14A9PS2, A9PS3, A9PS4, Overcurrent Adjustment and Performance Test Procedures	3-143
3-27	Test Equipment Required for Power Supply 14A9PS2, A9PS3, A9PS4 Output Voltage Adjustment	3-146
3-28	Test Equipment Required for Power Supply HTA-9A1PS1, 9A1PS2, 9A1PS3 Output Voltage Adjustment	3-157
3-29	Test Equipment Required for 15 VDC Gate HTA-9A1PS3 Overcurrent Adjustment	3-158
3-30	Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Integrator Limit Adjustment	3-162
3-31	Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3, Tachometer Balance Adjustment	3-164
3-32	Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 DC Offset Adjustment	3-164
3-33	Test Equipment Required for Servo and Control Equipment Group Performance Test Procedure	3-183
3-34	Servo and Control Equipment Group Performance Test Procedure	3-184
3-35	Instrument Servo Assembly 14A8A1, A8A2 Performance Test Procedure	3-187
3-36	15 VDC and −15 VDC Power Supply 14A9PS2, A9PS3 Performance Test Procedure	3-191
3-37	5 VDC Power Supply 14A9PS4 Performance Test Procedure	3-192
3-38	Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Performance Test Procedure	3-194
3-39	Electronic Control Amplifier HTA-9A2, 9A3 Performance Test Procedure	3-196
3-40	Power Supply Control HTA-9A1 Performance Test Procedure	3-198
3-41	Test Equipment required for 5 VDC Power Supply HTA-9A1PS1 Performance Test Procedure	3-199
3-42	5 VDC Power Supply HTA-9A1PS1 Performance Test Procedure	3-202
3-43	Test Equipment Required for Dual 15 VDC Power Supply HTA-9A1PS2 Performance Test Procedure	3-203
3-44	Dual 15 VDC Power Supply HTA-9A1PS2 Performance Test Procedure	3-205
3-45	Test Equipment Required for 15 VDC Gate Power Supply HTA-9A1PS3 Performance Test Procedure	3-206
3-46	15 VDC Gate Power Supply HTA-9A1PS3 Performance Test Procedure	3-208
4-1	Tools and Test Equipment Required for Maintenance	4-1

CHAPTER 1

INTRODUCTION

SECTION I. GENERAL

1-1. Scope. This manual contains direct and general support instructions for the servo and control equipment in Satellite Communications Terminals AN/FSC-78(V), AN/FSC-79 and AN/GSC-39(V). Unless otherwise specified, information applicable to the AN/FSC-78(V) is also applicable to the AN/GSC-39(V). Included are discussions on how the equipment functions, and procedures for troubleshooting, testing, and adjusting the equipment. Maintenance instructions are included for repairing the equipment and for replacing specified maintenance parts. Also included are lists of tools, materials, and test equipment required for direct and general support maintenance.

1-2. Maintenance Forms, Records, and Reports.

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, as contained in Maintenance Management Update (Army). Air Force personnel will use AFR 66-1 for maintenance reporting and TO-00-35D54 for unsatisfactory quipment reporting. Navy personnel will report aintenance performed utilizing the Maintenance Data Collection Subsystem (MDSC) IAW OP-NAVINST 4790.2, Vol 3 and unsatisfactory aterial/conditions (UR submissions) IAW OP-NAVINST 4790.2, Vol 2, chapter 17.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/NAVMATINST 4355.73A/AFR 400-54/MCO 4430.3F.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/DLAR 4500.15.

1-3. Administrative Storage. Administrative storage of equipment issued to and used by Army activities shall be in accordance with TM 740-90-1.

1-4. Reporting Equipment Improvement Recommendations (EIR).

a. Army. If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703. We'll send you a reply.

b. Air Force. Air Force personnel are encouraged to submit EIR's in accordance with AFR 900-4.

c. Navy. Navy personnel are encouraged to submit EIR's through their local Beneficial Suggestion Program.

SECTION II. DESCRIPTION AND DATA

1-5. General Description. The servo and control quipment is part of the tracking functional group escribed in the following technical manuals:

TM 11-5895-898-12	Operator and Organizational Maintenance Manual for Satellite Communication Terminal AN/FSC-78(V)
TM 11-5895-899-12	Operator and Organizational Maintenance Manual for Satellite Communication Terminal AN/FSC-79(V)
TM 11-5895-1050-12	Operator and Organizational Maintenance Manual for Satellite Communication Terminal AN/GSC-39(V)1
TM 11-5895-1043-12	Operator and Organizational Maintenance Manual for Satellite Communication Terminal AN/GSC-39(V)2
TM 11-5985-358-14	Operator, Organizational, Direct Support and General Support Maintenance Manual for Antenna Group OE-222/G for Satellite Communication Terminal AN/GSC-39(V)

a. Purpose and Use. The servo and control equipment provides the servoelectronics and electromechanical power to manually or automatically position the 60-foot antenna reflector assembly in azimuth and elevation, to point it toward a communication satellite.

b. Servo and Control Equipment Configuration for AN/FSC-78(V) and AN/FSC-79. The servo and control equipment configuration for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79 is shown in the frontispiece and identified in table 1-1.

Table 1-1 Servo and Control Equipment

Ref des	Official nomenclature	Common name
14A7	Antenna Position-Status Indicator ID-1912/G	Antenna position and status panel
14A8	Antenna Control C-9402/G	Antenna control panel
14A9	Power Supply Assembly PP-6959/G	Servo power supply assembly
HTA-2A1S1	Reflector Door Switch	Reflector door switch
HTA-4A7, 6A9, 8A10, 8A27	ANT OPR/ANT SAFE Switch Assembly	Antenna safe switch
HTA-6A6	Elevation Synchro Assembly	Elevation synchro assembly
HTA-6A6A1	Antenna Synchro SN/498/FSC	Elevation data module
HTA-8A7	Synchro Assembly/Cable Wrap Assembly	Azimuth cable wrap and data module assembly
HTA-8A7A1	Antenna Synchro SN-482/FSC	Azimuth data module
HTA-8A24	Control Indicator ID-1936/G	Stow pin control/minor fault summary panel
HTA-9	Direct Current Control C-9849/FSC	Direct current control
HTA-9A1	Power Supply Control	Power supply control
HTA-9A2	Electronic Control Amplifier	Elevation electronic control amplifier
HTA-9A3	Electronic Control Amplifier	Azimuth electronic control amplifier
HTA-12	Antenna Ancillary Group	Antenna ancillary group
HTA-12A1, 12A3	Antenna, Electromechanical Drive Assembly TG-232/FSC	Azimuth drive motor assembly 1 and 2
HTA-12A2, 12A4	Antenna, Electromechanical Drive Assembly TG-232/FSC	Elevation drive motor assembly 1 and 2
HTA-P201	Electrical Breakaway Connector Plug	Breakaway electrical connector plug

1-6. Antenna Control Panel 14A8 (fig.1-1). Antenna control panel 14A8 provides front panel controls and indicators to select and monitor servo modes, manually position the reflector to desired azimuth and elevation coordinates, and monitor the position in degrees of axial rotation. Panel handcrank and slew potentiometer controls permit the operator to manually position the antenna in the azimuth and elevation axes. Azimuth and elevation decimal counters display antenna position in degrees and tenths of degrees; indicators display servo limit status; push switches permit selection of standby, manual, slave, or acquisition/autotrack modes of servo operation. The handcrank controls are functionally part of azimuth and elevation instrument servo assemblies A1 and A2 mounted behind the front panel. The rear panel of the antenna control panel contains one multipin electrical connector. The antenna control panel includes a console mountable chassis fitted with slide assemblies that allow the unit to be extended outward from the console to facilitate maintenance.

1-7. Antenna Position and Status Panel 14A7 (fig.-1-2). Antenna position and status panel 14A7 provides fault status and antenna position readouts and also provides the electronics to implement mode selection and signal conditioning. The front panel contains position indicators to indicate the angular position of the antenna in the azimuth and elevation axes, indicators to provide servo equipment status, and a key-operated antenna safe switch to prevent antenna movement during maintenance or emergency conditions. The azimuth and elevation position indicators each contain a dial and a synchro driven pointer. The azimuth position indicator dial indicates from 0 to 360 degrees and the elevation position indicator dial indicates from 0 to 90 degrees. Mounted internally are a power transformer, three relays, and an electrical equipment chassis. The electrical equipment chassis

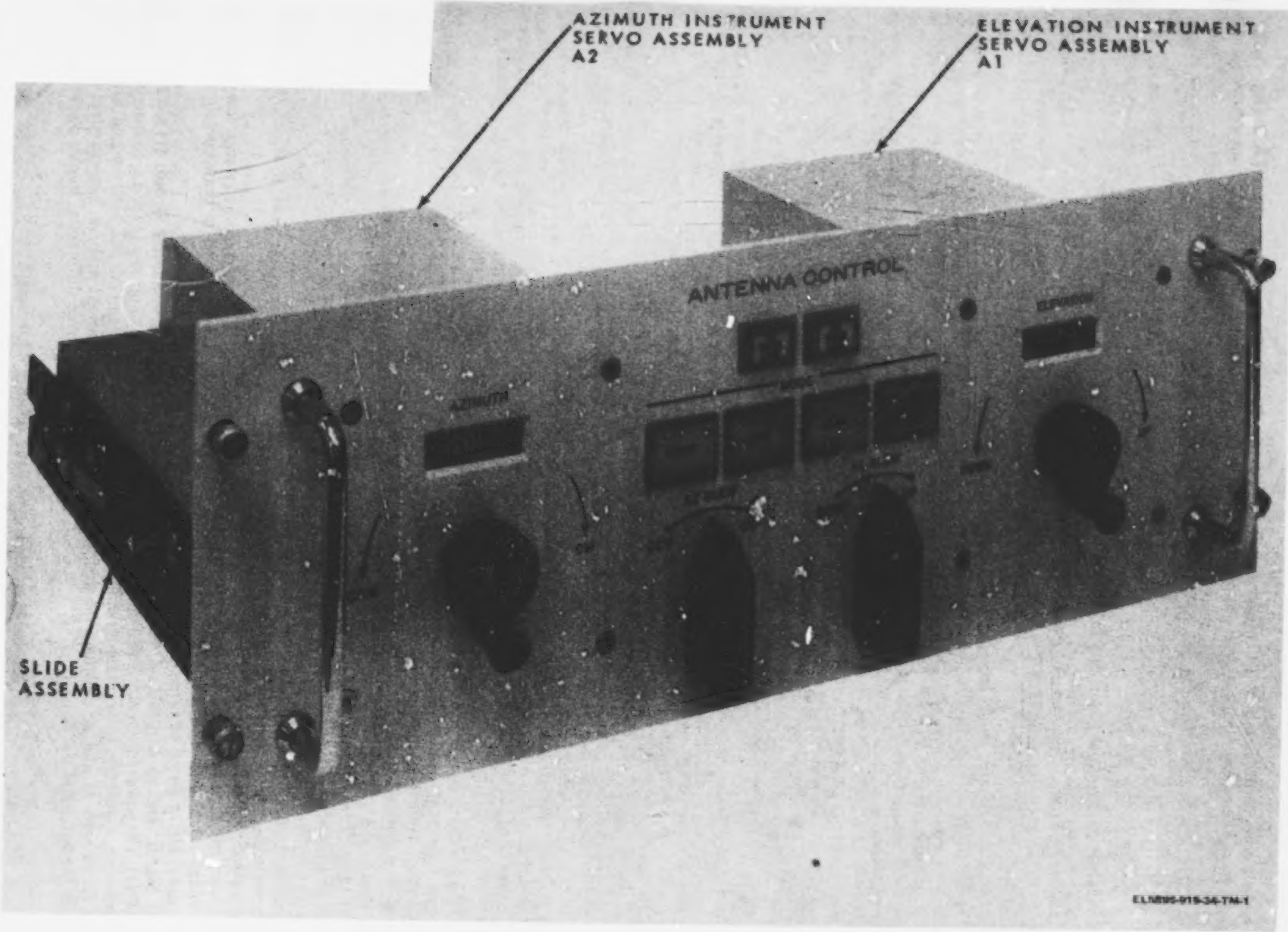

AZIMUTH INSTRUMENT SERVO ASSEMBLY A2
ELEVATION INSTRUMENT SERVO ASSEMBLY A1
ANTENNA CONTROL
AZIMUTH
ELEVATION
SLIDE ASSEMBLY
EL5895-915-34-TM-1

Figure 1-1. Antenna control panel 14A8.

houses seven circuit card assemblies (A1 through A7). The rear panel of the antenna position and status panel contains 10 multipin connectors (J1 through J10) and ground stud E1. The antenna position and status panel includes a console mountable chassis fitted with slide assemblies that allow the unit to be pulled outward from the console to facilitate maintenance.

1-8. Servo Power Supply Assembly 14A9 (fig. 1-3). Servo power supply assembly 14A9 contains dc power supplies and transformers to provide dc output voltages of +5 V dc, +15 V dc, -15 V dc, and +26 V dc and ac output voltages of 120 and 20 V ac for the servo and control equipment. Mounted on the front panel are seven circuit breaker switches to control application of power and to provide overload protection for the unit, and a selector switch and meter to monitor the output voltages. Internally mounted are a power transformer, four modular power supplies, a heat sink, and three overvoltage protectors.

a. The power supplies consist of four units having output voltages of +26 V dc (PS1), +15 V dc (PS2), -15 V dc (PS3), and +5 V dc (PS4). Three units, the +5 V dc, +15 V dc, and -15 V dc power supplies, are each provided with a voltage adjust screw on the front of the unit, and an adjustable overvoltage protection module mounted on the rear of the unit. The units are mounted front-to-top, rear-to-bottom of the servo power supply assembly. The +26 V dc power supply is a sealed unit that is adjustable but not field repairable.

b. The rear panel of servo power supply assembly 14A9 contains connectors J1 and J2, ground lug E1, and an access hole for adjusting the +26 V dc output power. The servo power supply assembly contains a console mountable chassis fitted with slide assemblies that permit the unit to be pulled outward from the console and rotated for access during maintenance operations.

1-9. Stow Pin Control/Minor Fault Summary Panel HTA-8A24 (fig. 1-4). Stow pin control/minor fault summary panel HTA-8A24 controls and monitors stow pin action, rain deflector operation, and minor fault sensing and signaling. The panel consists of a wall-mountable electrical equipment chassis with a hinged front panel. Mounted on the front panel are controls and indicators to indicate minor fault status, select and signify maintenance operation, and control operation of the feed assembly rain deflector and stow pins. The front panel also includes a circuit breaker to control power input and to provide overcurrent protection. The hinged front panel permits access to the interior of the unit. Mounted on the interior panel are 15 relays on three angle brackets, two terminal boards, and an unregulated +26 V dc power supply (PS1). The power supply is a sealed unit and is not field repairable. A junction box containing multipin connectors J1 through J4 and ground lugs E1 and E2 is located at the bottom of the chassis.

1-10. Direct Current Control HTA-9 (fig. 1-5). Direct current control HTA-9 contains electronics to analyze error signals and to control operation of the two azimuth and two elevation antenna drive motor assemblies. The direct current control also provides for local monitoring of minor drive and internal faults to facilitate troubleshooting. The direct current control is housed in a 72-inch high electrical equipment cabinet (fig. 1-5, sh 1), containing front and rear hinged doors to permit access to internal equipment components. One radio frequency interference (rfi) air filter is located on the lower right side and one is located on the upper left side of the cabinet. Assembly inputs and outputs are cabled directly to terminal boards or connecting terminals located on the subassemblies. The cabinet houses power supply control HTA-9A1 (fig. 1-5, sh 2), elevation and azimuth electronic control amplifiers HTA-9A2 and HTA-9A3 (fig. 1-5, sh 3), dual power inductors L1 through L4, contactors K1 and K2, and axial cooling fan B1.

a. Power supply control HTA-9A1 provides dc operating power for direct current control HTA-9. The front panel mounts two circuit breakers to control application of ac power, and four fuses for the motor fields of the two azimuth and two elevation antenna drive assembly motors. In addition, two 120 V ac receptacles are provided on the front panel for connection of power to test equipment. Mounted at the rear of the assembly are +5 V dc, dual 15 V dc, and +15 V dc gate modular power supplies and three relays.

b. Elevation and azimuth electronic control amplifiers HTA-9A2 and HTA-9A3 are identical. Each assembly performs 3-phase, bidirectional rectification of 277/480 V ac in response to velocity command and feedback signals, to provide dc drive current for operation of the respective antenna drive motor assemblies. The front panel of each electronic control amplifier mounts three line fuses for the 277/480 V ac input power and circuit card assembly A1. Mounted on the rear of each electronic control amplifier are six scr assemblies (A2 through A7) and related fuses.

c. The four dual power inductors (L1 through L4), which distribute the dc drive current to two azimuth and two elevation drive motor assemblies, are located in the bottom of the cabinet.

d. Contactors K1 and K2 are mounted on supports attached to the cabinet right and left sides toward the rear of the cabinet.

e. Fan B1 is located on the interior lower right side of the cabinet and is used to draw cooling air into the cabinet.

1-11. Antenna Ancillary Group HTA-12 (fig. 1-6). Antenna ancillary group HTA-12 consists of elevation drive motor assemblies A2 and A4 and azimuth drive motor assemblies A1 and A3. The elevation drive motor assemblies provide differential torque power for driving

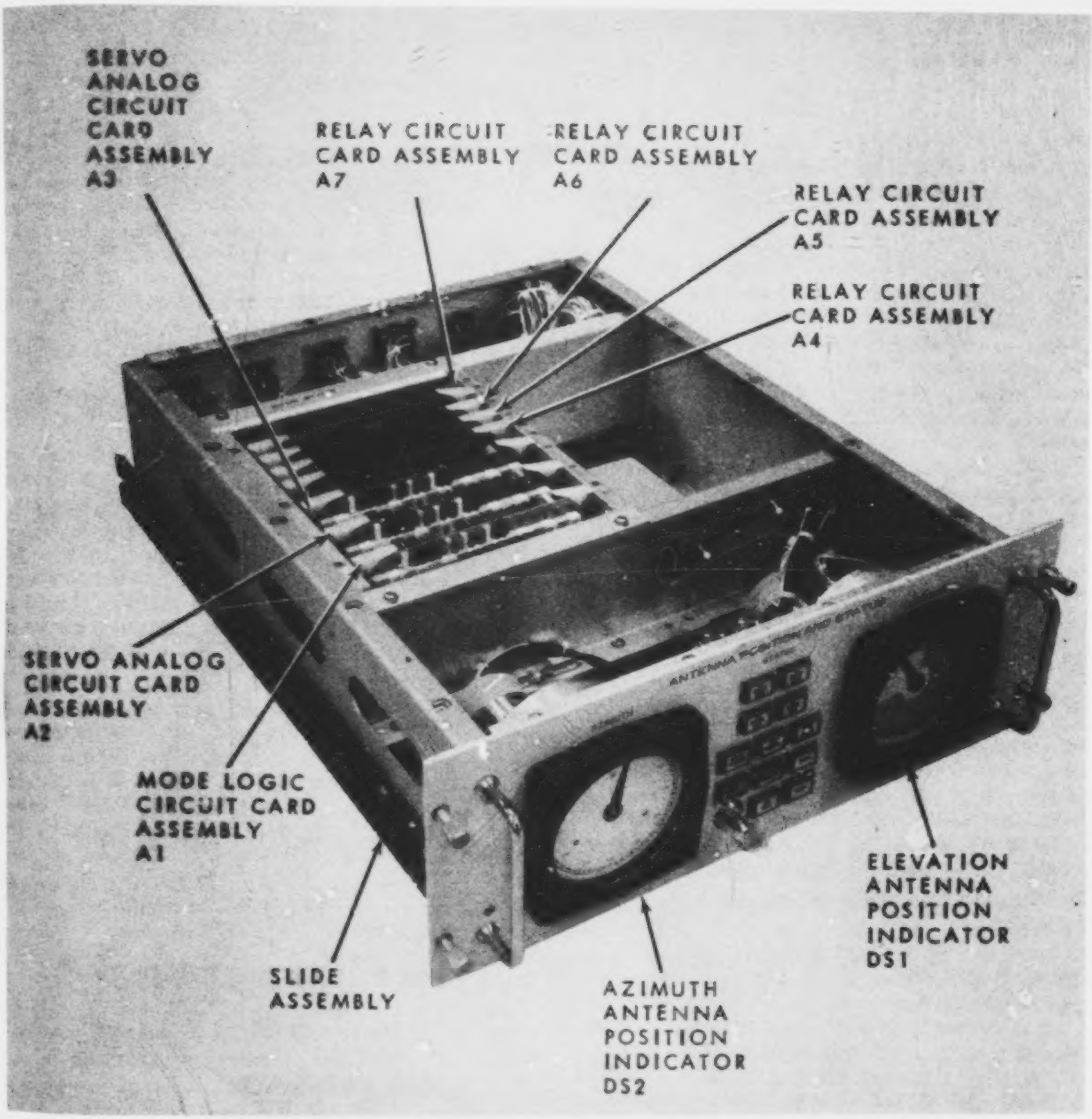

SERVO ANALOG CIRCUIT CARD ASSEMBLY A3
RELAY CIRCUIT CARD ASSEMBLY A7
RELAY CIRCUIT CARD ASSEMBLY A6
RELAY CIRCUIT CARD ASSEMBLY A5
RELAY CIRCUIT CARD ASSEMBLY A4
SERVO ANALOG CIRCUIT CARD ASSEMBLY A2
MODE LOGIC CIRCUIT CARD ASSEMBLY A1
SLIDE ASSEMBLY
AZIMUTH ANTENNA POSITION INDICATOR DS2
ELEVATION ANTENNA POSITION INDICATOR DS1
ANTENNA POSITION AND STATUS
AZIMUTH
EL5895-915-34-TM-2

Figure 1-2. Antenna position and status panel 14A7.

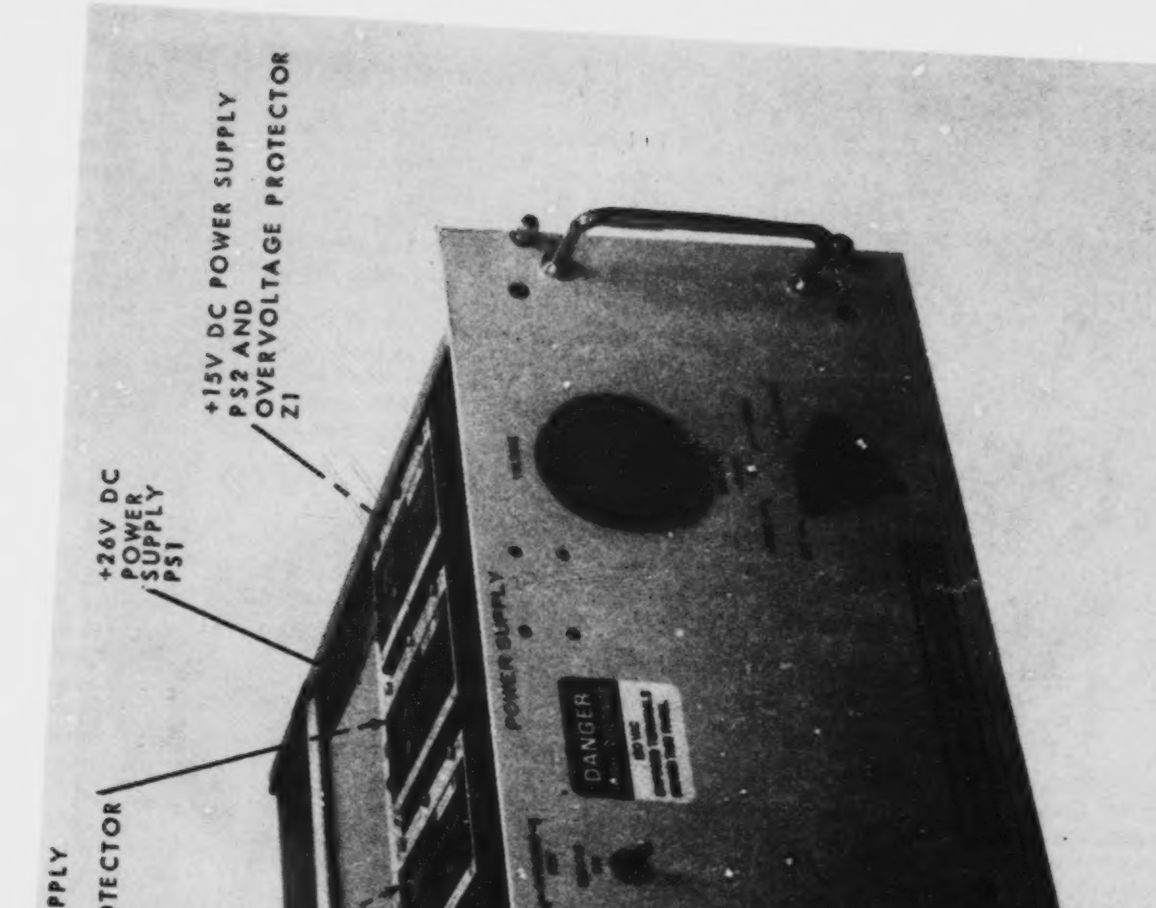
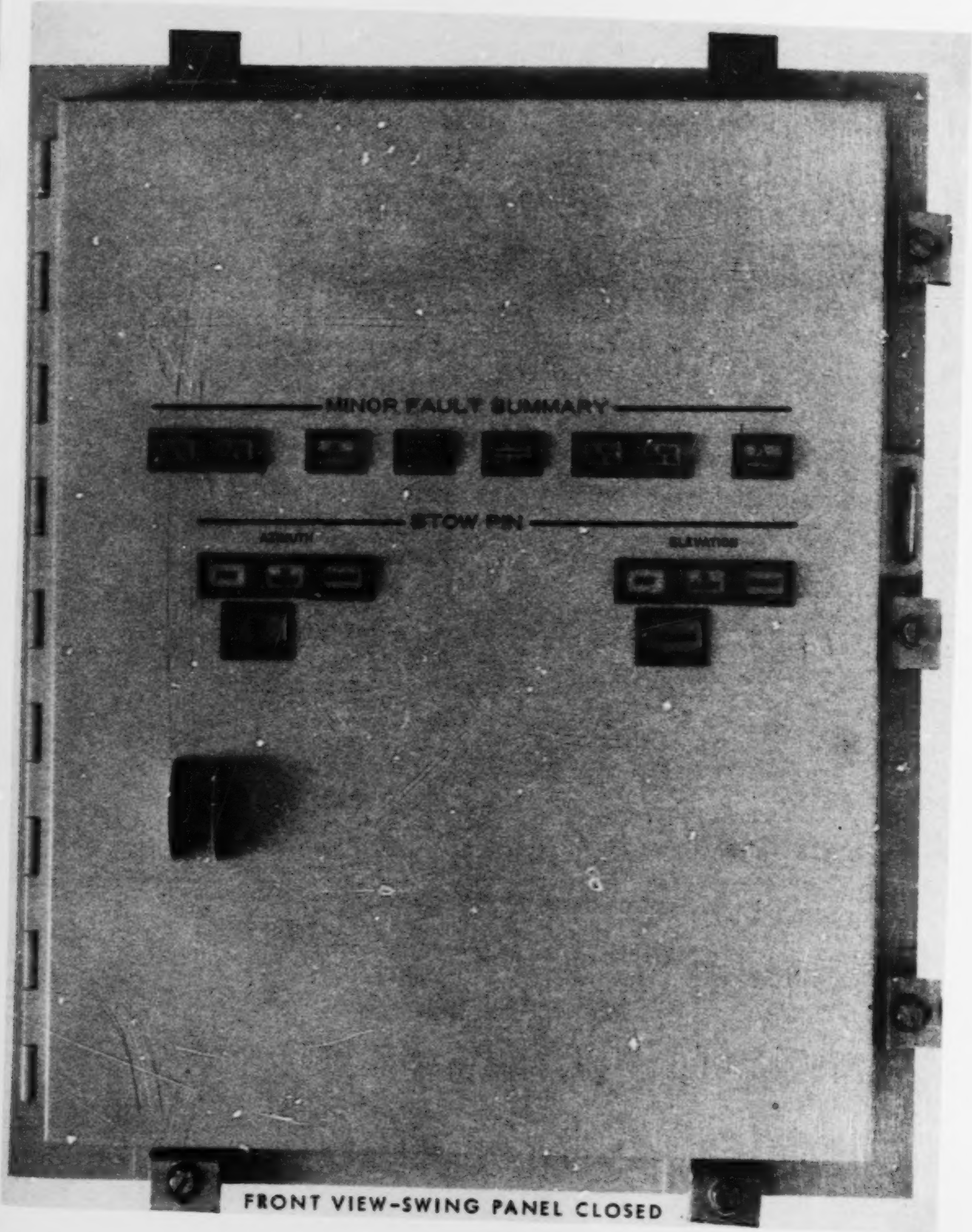

-15V DC POWER SUPPLY
PS3 AND
OVERVOLTAGE PROTECTOR
Z2
+5V DC POWER SUPPLY
PS4 AND
OVERVOLTAGE PROTECTOR
Z3
+26V DC
POWER
SUPPLY
PS1
+15V DC POWER SUPPLY
PS2 AND
OVERVOLTAGE PROTECTOR
Z1
SLIDE
ASSEMBLY
POWER SUPPLY
DANGER

Figure 1-3. Servo power supply assembly 14A9.


MINOR FAULT SUMMARY
STOW PIN
AZIMUTH
ELEVATION
FRONT VIEW-SWING PANEL CLOSED

EL5895-915-34-TM-4 ①

Figure 1-4. Stow pin control/minor fault summary panel HTA-8A24 (sheet 1 of 2).

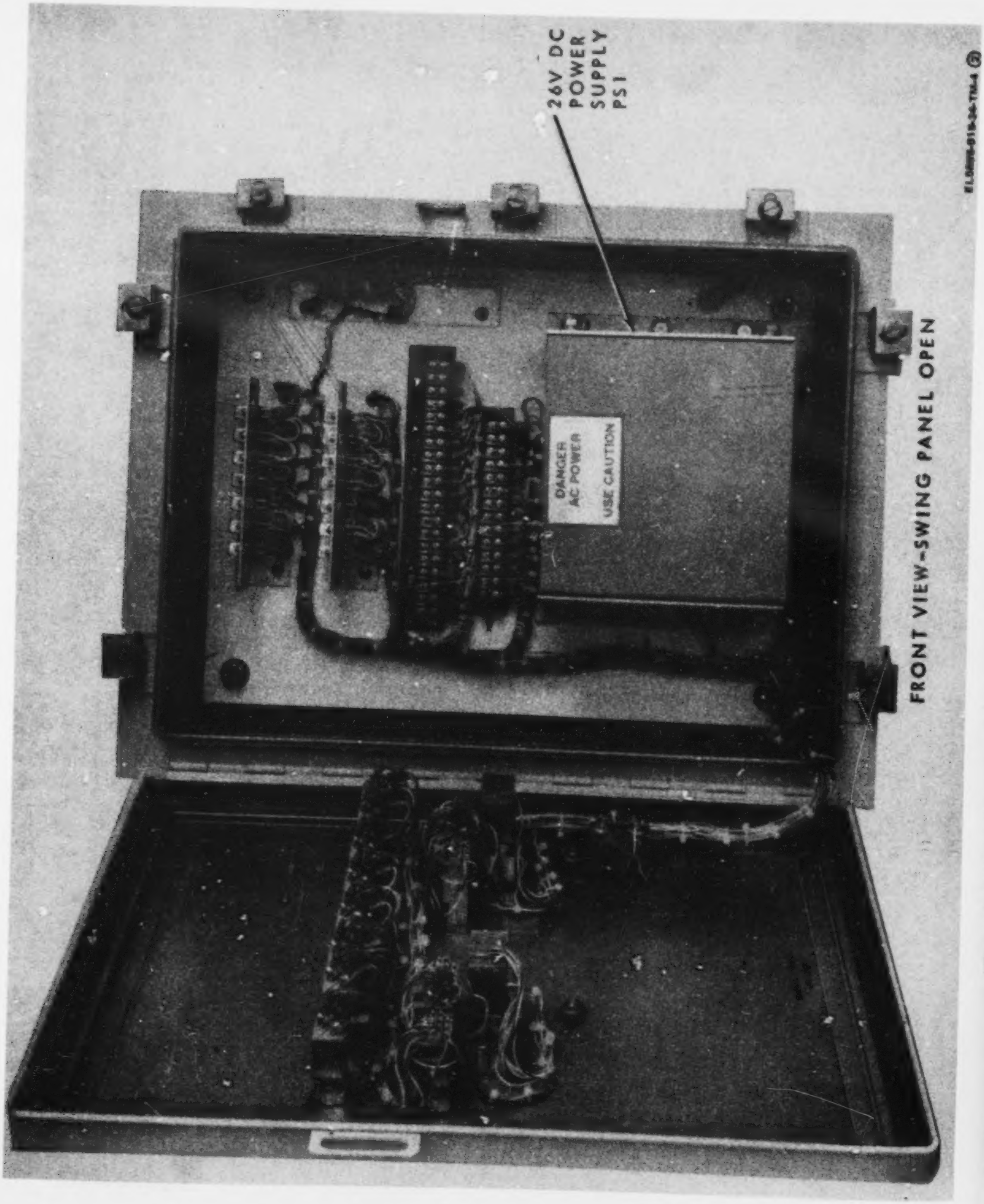

26V DC POWER SUPPLY PS1
DANGER
AC POWER
USE CAUTION
FRONT VIEW-SWING PANEL OPEN
EL5895-915-34-TM-4 (2)

Figure 1-4. Stow pin control/minor fault summary panel HTA-8A24 (sheet 2 of 2).

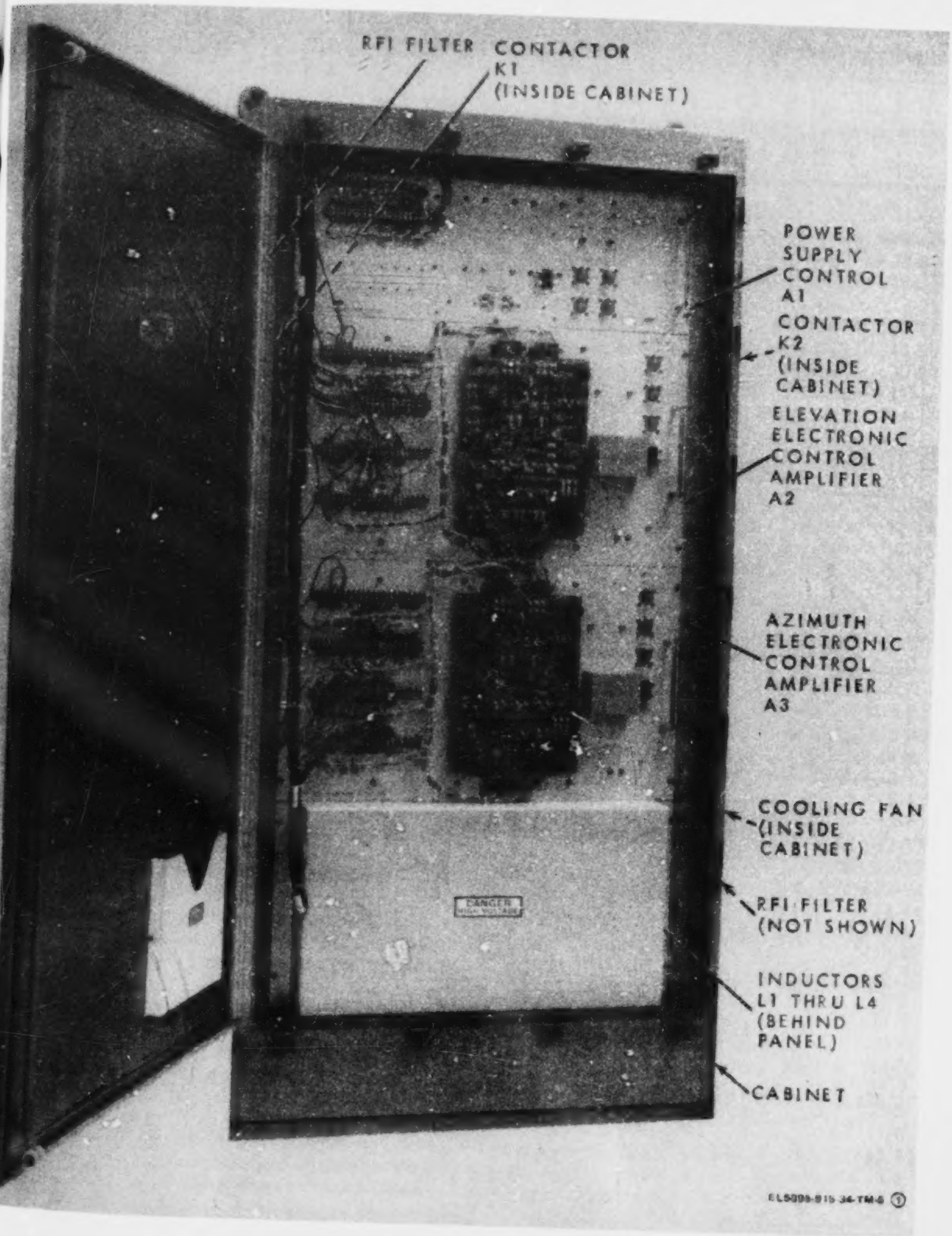

RFI FILTER
CONTACTOR K1 (INSIDE CABINET)
POWER SUPPLY CONTROL A1
CONTACTOR K2 (INSIDE CABINET)
ELEVATION ELECTRONIC CONTROL AMPLIFIER A2
AZIMUTH ELECTRONIC CONTROL AMPLIFIER A3
COOLING FAN (INSIDE CABINET)
RFI FILTER (NOT SHOWN)
INDUCTORS L1 THRU L4 (BEHIND PANEL)
CABINET
DANGER HIGH VOLTAGE
EL5895-915-34-TM-6 ①

Figure 1-5. Direct current control HTA-9 (sheet 1 of 3).

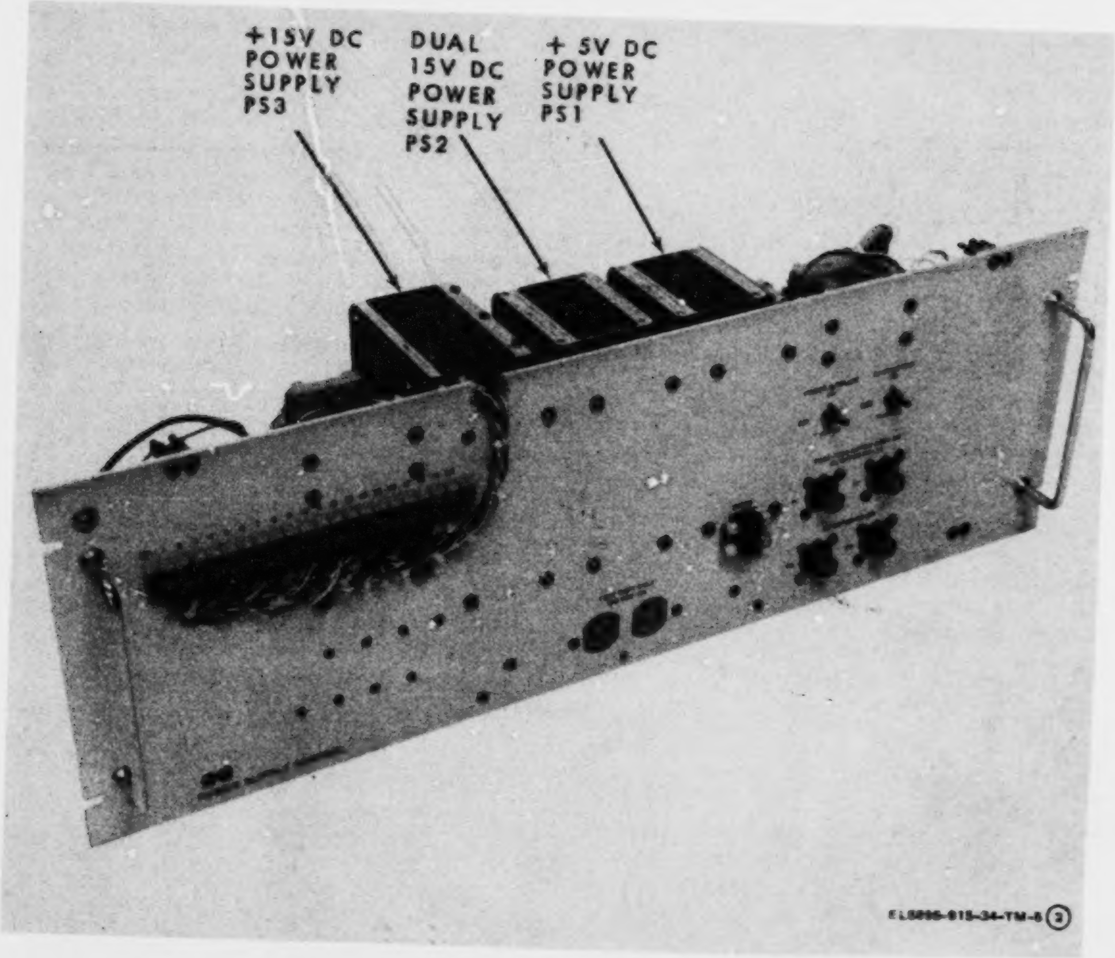

+15V DC POWER SUPPLY PS3
DUAL 15V DC POWER SUPPLY PS2
+ 5V DC POWER SUPPLY PS1
EL5895-915-34-TM-5 ②

Figure 1-5. Direct current control HTA-9 (sheet 2 of 3).

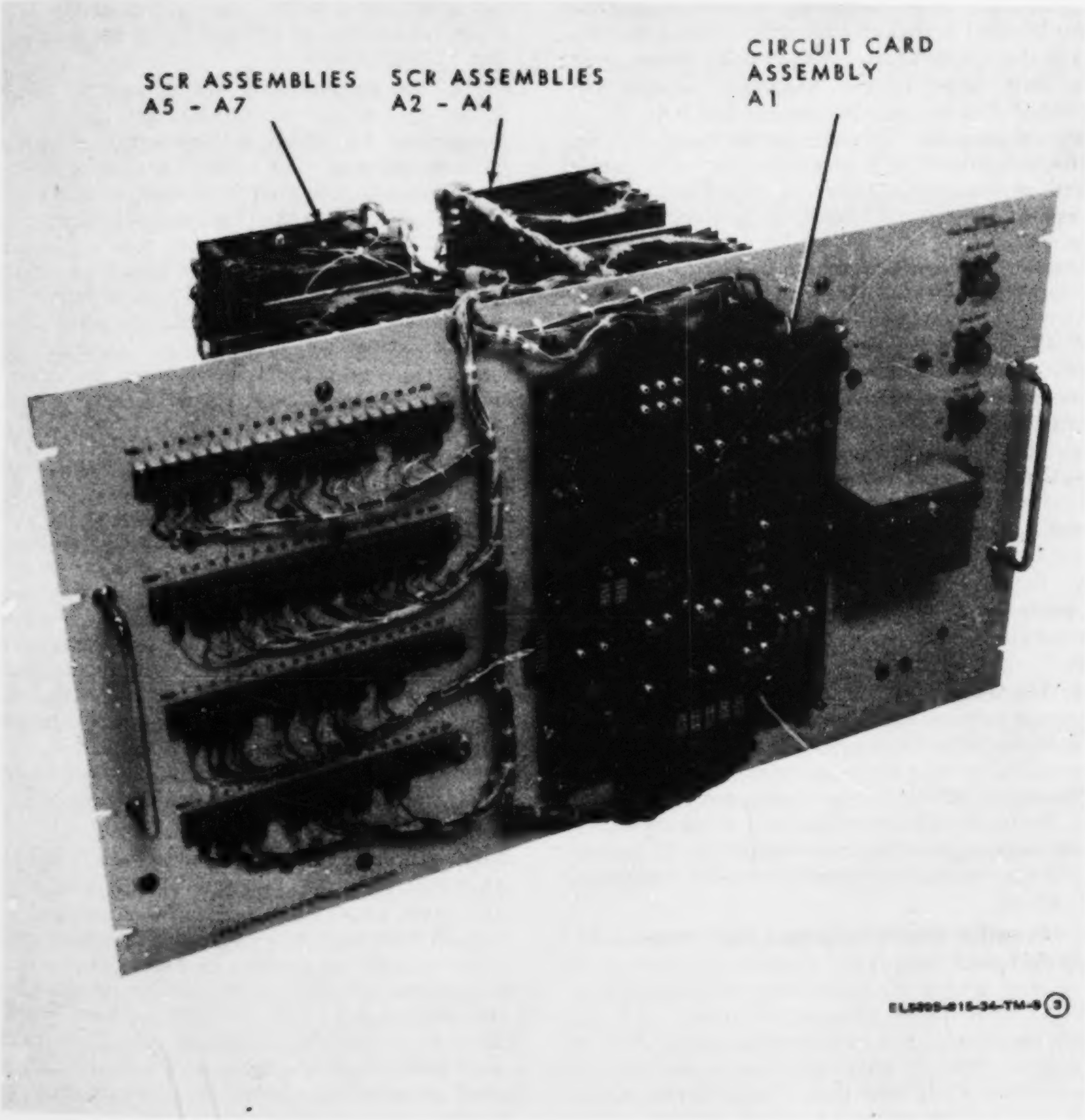

SCR ASSEMBLIES
A5 - A7
SCR ASSEMBLIES
A2 - A4
CIRCUIT CARD
ASSEMBLY
A1
EL5895-915-34-TM-5 ③

Figure 1-5. Direct current control HTA-9 (sheet 3 of 3).

the antenna in the elevation axis; the azimuth drive motor assemblies provide differential torque power for driving the antenna in the azimuth axis. Elevation drive motor assemblies A2 and A4 are mounted on the antenna group yoke subassembly, and azimuth drive motor assemblies A1 and A3 are mounted in the antenna group tower.

a. Each drive motor assembly includes 10-horsepower dc drive motor B1, electric disk brake A1, dc tachometer generator G1, and ac motor blower B2. The dc drive motor operates in either direction; it contains a thermal overload switch inside the motor housing to protect against over-heating. Each dc drive motor is secured to the input motor mounting on the associated azimuth or elevation speed reducer gear assembly (gear box). The electric disk brake and dc tachometer-generator are attached to the dc drive motor and operate on the dc drive motor shaft extension. The shaft is also coupled to the speed-reducing gears that drive the antenna. Information pertaining to the azimuth and elevation gear boxes is contained in TM 11-5895-900-34.

b. The electric disk brake contains self-adjusting friction disks. The disks are spring set and are electrically or manually released to prevent uncontrolled antenna movement. The brakes are manually released by pulling a hand lever located on the brake assembly.

c. The dc tachometer-generator is attached to the dc drive motor by a coupling adapter and provides dc feedback voltages that are proportional to the speed of the motor.

d. The blower to cool the dc drive motor and the 1/3 horsepower ac motor that drives the blower are bolted to the dc drive motor housing. Two waterproof junction boxes secured to the dc drive motor housing provide wiring terminating points for the dc drive motor, electric disk brake, dc tachometer-generator, and ac motor blower electrical connections. Electrical wiring from the junction boxes to the various units is routed through flexible and rigid conduit.

1-12. Azimuth Cable Wrap and Data Module Assembly HTA-8A7 (fig. 1-7). Azimuth cable wrap and data module HTA-8A7A1 and cable wrap assembly A2 (fig. 1-7). The cable wrap assembly consists of cabling hangers, straps, and rings to support routing of cables in the antenna tower. The azimuth data module provides antenna azimuth positional data, in the form of synchro signals, to servo equipment for analysis and display. The azimuth data module also provides antenna limit signals to servo equipment to permit operator control of antenna drive.

a. One section of the emergency breakaway connector is fastened to a stationary frame and the other section is fastened by steel cable to a cable wrap assembly ring that rotates in azimuth with the antenna. The steel cable pulls the two sections of the connector apart when antenna rotation in the azimuth axis exceeds ±240 degrees from the azimuth stow position. Connector separation halts further movement of the antenna and prevents damage to the cables in the cable wrap assembly. For additional information on the cable wrap assembly, refer to TM 11-5895-900-34.

b. The azimuth data module consists of synchro torque transmitter 23TX6AB3, two synchro control transmitters 23CX6AB1,B2, cam-operated limit switch S1, and associated gears mounted in a sealed, pressurized (1 psi) housing. The assembly is mechanically coupled to the antenna azimuth axis. The synchro torque transmitter provides antenna azimuth position data to antenna position and status panel 14A7; the synchro control transmitters provide antenna azimuth position data to antenna control panel 14A8 or an external slave source. The limit switches provide antenna servo limit (prelimit) status to the antenna control panel and electrical limit status to the antenna position and status panel.

1-13. Elevation Synchro Assembly HTA-6A6 (fig. 1-8). Elevation synchro assembly HTA-6A6 comprises elevation data module HTA-6A6A1 and the coupling and support assemblies. The elevation data module is identical to the azimuth data module discussed in paragraph 1-12b and illustrated in figure 1-7, with the exception of the external gear arrangement and coupling interface. The elevation data module main shaft is mechanically coupled to the elevation axis at one of the antenna reflector main bearing hubs. Elevation data module signal outputs are identical with those of the azimuth data module with the exception that there is an added cam-operated limit switch function. A separate segment of the cam-operated limit switch provides a low elevation transmitter cutoff status signal to Control-Monitor C-9861/G or C-9854/G (system status logic unit 15A5).

1-14. Antenna Safe Switch HTA-4A7, 6A9, 8A10, 8A27 (fig. 1-9). The four antenna safe switches (HTA-4A7, 6A9, 8A10, and 8A27) provide emergency servo turn-off from various locations in the antenna structure. These switches are electrically connected in series with the key-operated antenna safe switch on antenna position and status panel 14A7, the reflector door switch, and cable wrap assembly electrical breakaway connector plug. Each assembly consists of an rfi shielded, waterproof enclosure that houses an alternate-action switch assembly containing two pushbuttons; one pushbutton is labeled ANT. OPR. and the other is labeled ANT. SAFE. A hinged cover is mounted over the ANT. OPR. pushbutton to prevent accidental operation when in the antenna safe condition.

1-15. Reflector Door Switch HTA-2A1S1 (fig. 1-10). Reflector door switch HTA-2A1S1 functions as a personnel safety control and consists of a double-pole, single-throw microswitch mounted adjacent to the reflector door. One pole of the switch is electrically connected in

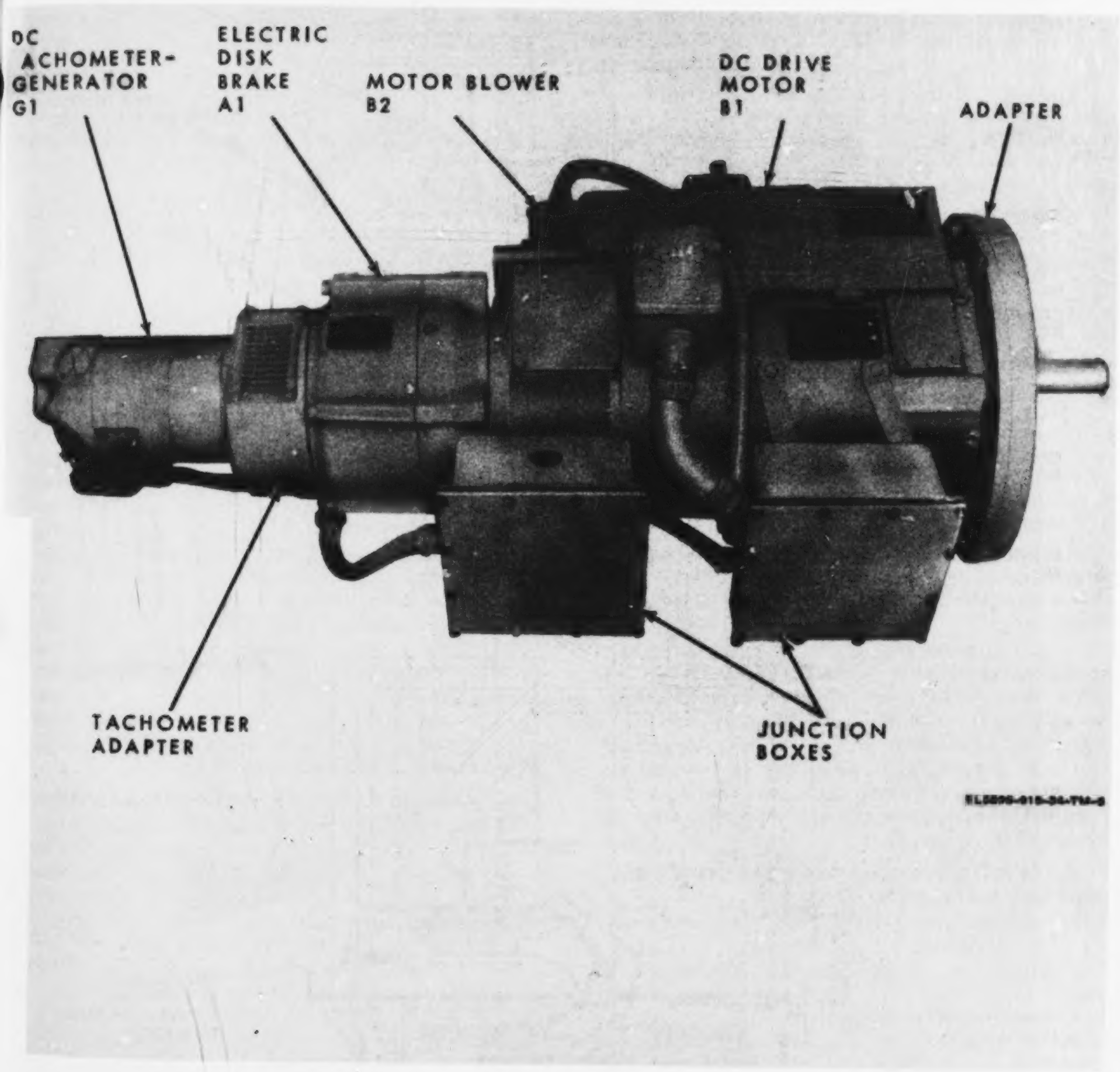
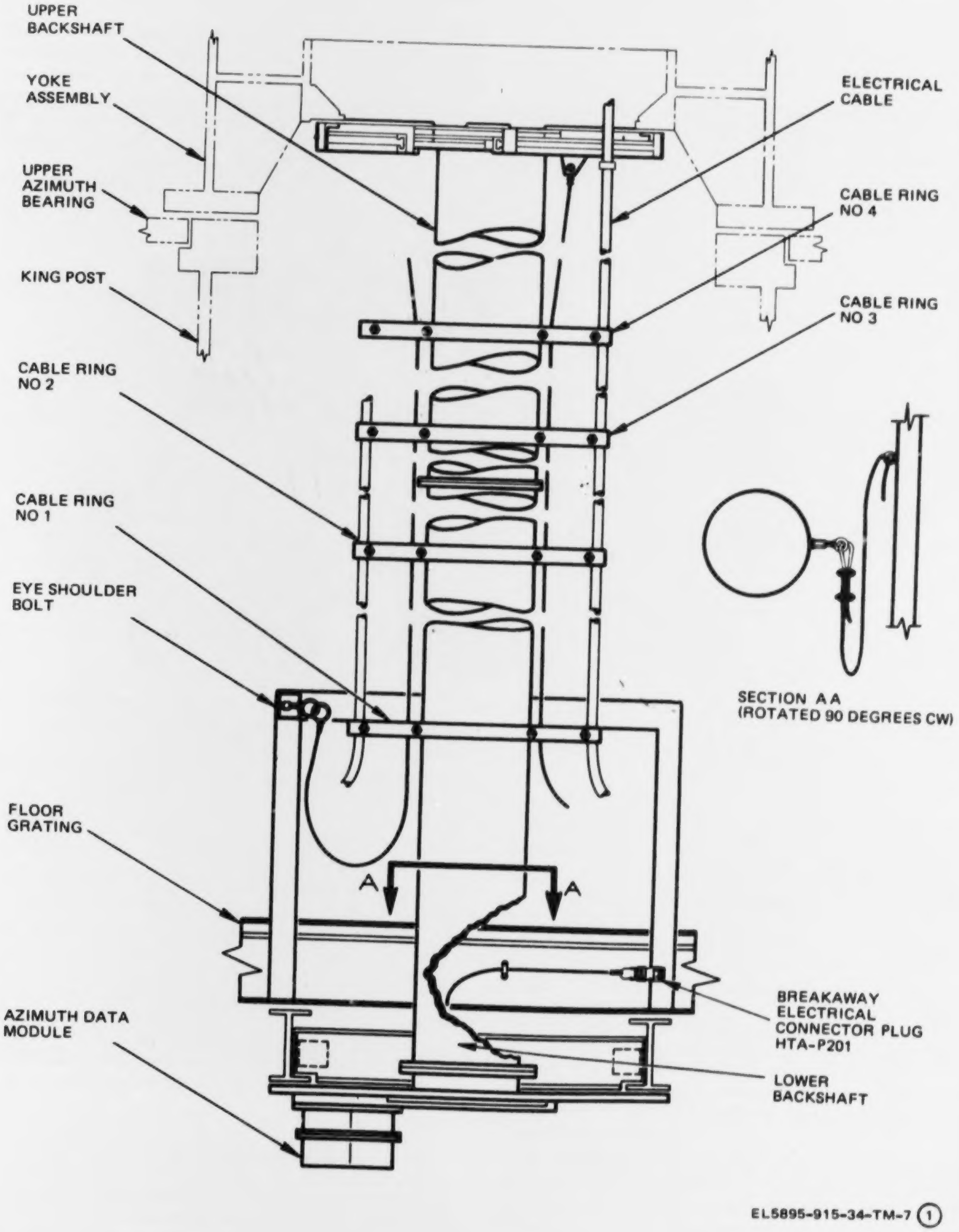
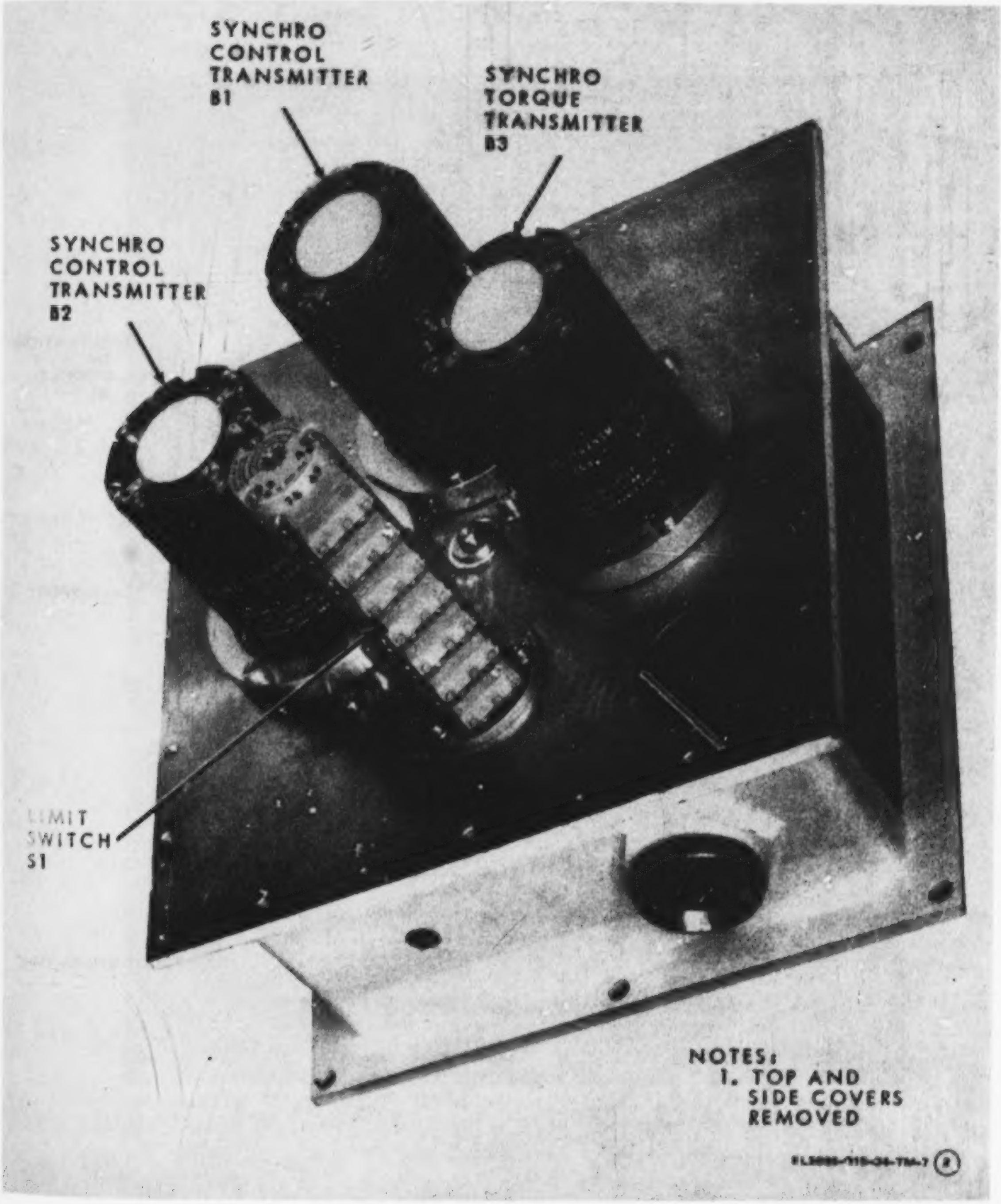

DC
ACHOMETER-
GENERATOR
G1
ELECTRIC
DISK
BRAKE
A1
MOTOR BLOWER
B2
DC DRIVE
MOTOR
B1
ADAPTER
TACHOMETER
ADAPTER
JUNCTION
BOXES
EL5895-915-34-TM-6

Figure 1-6. Azimuth/elevation drive motor assembly 1 and 2, HTA-12A1 through 12A4.


UPPER BACKSHAFT
YOKE ASSEMBLY
UPPER AZIMUTH BEARING
KING POST
CABLE RING NO 2
CABLE RING NO 1
EYE SHOULDER BOLT
FLOOR GRATING
AZIMUTH DATA MODULE
ELECTRICAL CABLE
CABLE RING NO 4
CABLE RING NO 3
SECTION A A (ROTATED 90 DEGREES CW)
A
A
BREAKAWAY ELECTRICAL CONNECTOR PLUG HTA-P201
LOWER BACKSHAFT

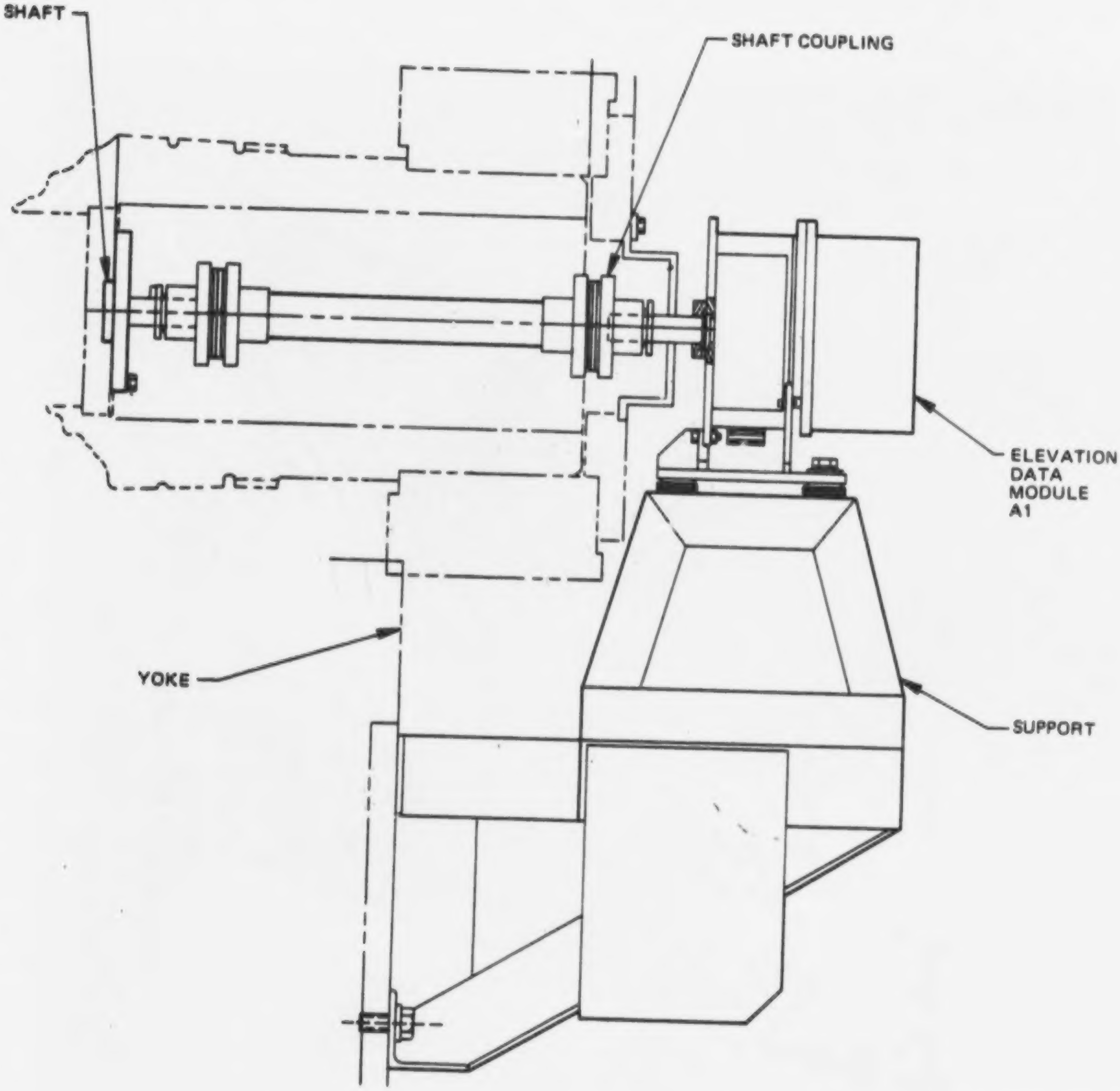
EL5895-915-34-TM-7 ①

Figure 1-7. Azimuth cable wrap and data module assembly HTA-8A7 (sheet 1 of 2).


SYNCHRO CONTROL TRANSMITTER B1
SYNCHRO TORQUE TRANSMITTER B3
SYNCHRO CONTROL TRANSMITTER B2
LIMIT SWITCH S1
FL5895-915-34-TM-7 ②

NOTES:
1. TOP AND SIDE COVERS REMOVED

Figure 1-7. Azimuth cable wrap and data module assembly HTA-8A7 (sheet 2 of 2).


SHAFT
SHAFT COUPLING
ELEVATION DATA MODULE A1
YOKE
SUPPORT

EL5895-915-34-TM-8

Figure 1-8. Elevation synchro assembly HTA-6A6.

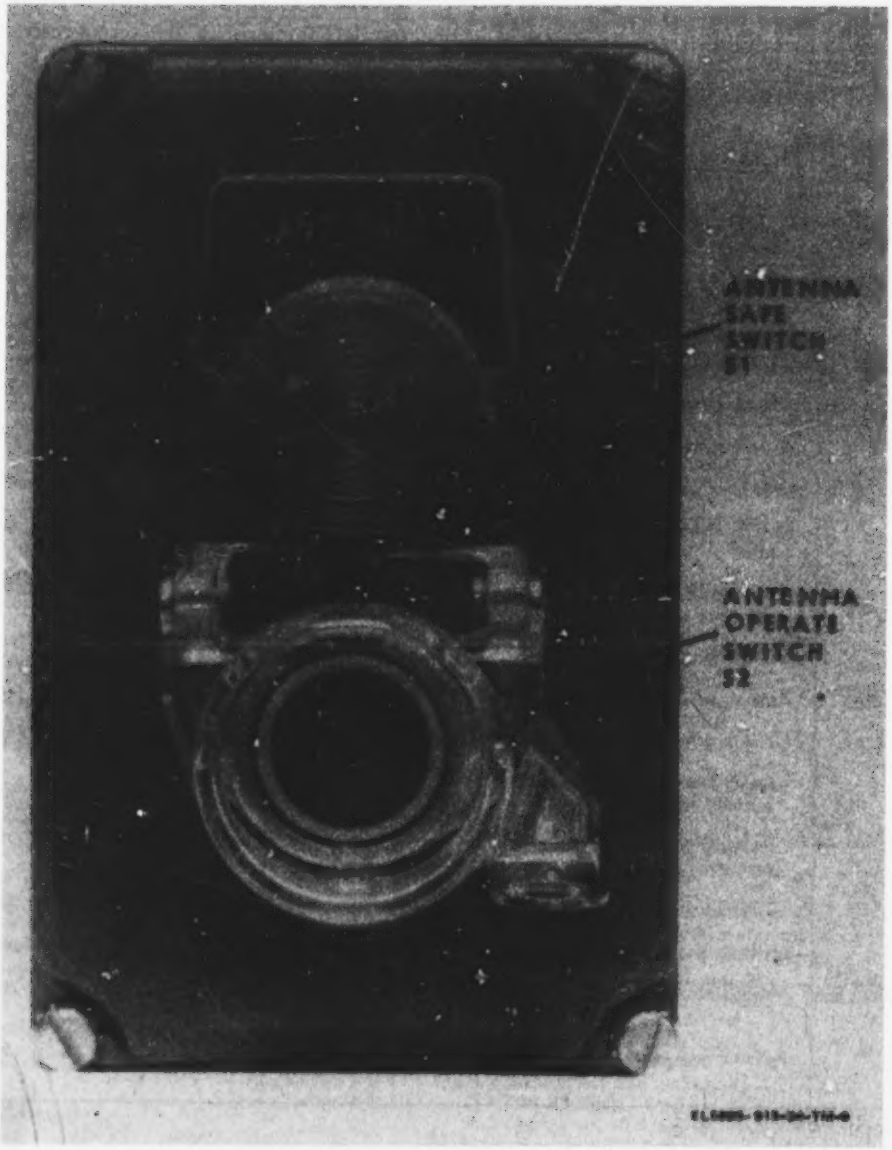

ANTENNA
SAFE
SWITCH
S1
ANTENNA
OPERATE
SWITCH
S2
EL5895-915-34-TM-9

Figure 1-9. Antenna safe switch HTA-4A7, 6A9, 8A10, 8A27

series with a segment of the limit switch in the elevation data module. The other pole is connected in series with the antenna safe switches. When the reflector door is opened, the switch causes online Radio Frequency Amplifier OG-131A/MSC (low power amplifier) to switch amplifier output to the dummy load to halt rf transmission.

1-16. Tabulated Data. This paragraph provides a tabulation of technical characteristics and a cross-reference index for the servo and control equipmen Technical characteristics include physical data and electrical characteristics. The cross-reference index relate equipment reference designations to functional group numbers.

a. Physical Data. Table 1-2 lists the physical characteristics of the servo and control equipment assemblies

Table 1-2 Dimensions and Weights

Ref des	Equipment	Qty	Dimensions (inches)			Weight (pounds)
			Height	Width	Depth	
14A8	Antenna control panel	1	7.0	19.0	12.0	65.0
14A7	Antenna position and status panel	1	7.0	19.0	22.0	65.0
14A9	Servo power supply assembly	1	10.5	19.0	17.0	40.0
HTA-8A24	Stow pin control/minor fault summary panel	1	21.3	16.0	7.2	50.0
HTA-9	Direct current control (includes mount and lifting eyebolt)	1	76.3	36.1	24.4	2500 (estimated)
HTA-12	Antenna ancillary group consisting of:					
HTA-12A1, HTA-12A3	Azimuth drive motor assembly 1 and 2	2	31.5 (ea)	21.5 (ea)	46.4 (ea)	480.0 (ea)
HTA-12A2, HTA-12A4	Elevation drive motor assembly 1 and 2	2	31.5	21.5	46.4	480.0
HTA-8A7	Azimuth cable wrap and data module assembly consisting of:					
HTA-P201	Cable wrap assembly electrical plug connector	1	1.0	(1.5 dia)	0.7	
HTA-8A7A1	Azimuth data module	1	8.5	8.5	8.0	40.0
HTA-6A6A1	Elevation data module	1	8.5	8.5	8.0	40.0
HTA-4A7, 6A9, 8A10, and 8A27	Antenna safe switches	4	6.0	3.5	3.0	1.0
HTA-2A1S1	Reflector door switch	1	0.5	1.5	2.0	0.4

b. Electrical Characteristics. Table 1-3 lists electrical characteristics of major assemblies in the servo and control equipment. Characteristics include power requirements, operating levels, and other pertinent data.

Table 1-3 Electrical Characteristics

Characteristic	Specification
Overall servo and control equipment	
Power requirements	120 ±12 V ac, 50 or 60 Hz, 1-ph, 3-wire; 120/208 V ac, 50 or 60 Hz, 3-ph 4-wire; 277/480 V ac, 50 or 60 Hz, 3-ph, 4-wire
Input signals:	
Azimuth/elevation tracking error	±7 V dc/degree of error
Azimuth/elevation slave error	±0.3 V dc/degree of error
Signal detected/signal acquired sequence	Relay contacts (+26 V dc)
Slave source available	Relay contacts (+26 V dc)
Nitrogen pressure status	Switch (+26 V dc)
Air conditioner/transmit filter status	Switch (+26 V dc)
Rain deflector on	Switch (+26 V dc)
Azimuth/elevation axis aligned	Switch (+26 V dc)
Azimuth/elevation retracted status	Switch (+26 V dc)
Azimuth/elevation stowed status	Switch (+26 V dc)
Azimuth/elevation handcrank engaged/stowed	Switch (+26 V dc)
Azimuth/elevation no. 1/no. 2 status	Switch (+26 V dc)
Output signals:	
Azimuth/elevation antenna position (syn-cx)	Synchro (two 3-wire at 85 V rms max)
Azimuth/elevation antenna position (syn-tx)	Synchro (one 3-wire at 85 V rms max)
Autotrack dropout	Relay contacts
Antenna major main tenance status	Switch
Slaved	Relay contacts (+26 V dc)
Antenna major fault	Relay contacts
Antenna minor fault summary status	Relay contacts
Antenna minor maintenance	Switch
Low elevation cutoff interlock	Switch
Azimuth/elevation retract command	+26 V dc
Azimuth/elevation stow command	+26 V dc
Rain deflector on command	+26 V dc
Operating limits (typical, see note):	

NOTE

Limits shown are for a specific site configuration in the northern hemisphere. Limits are measured from true north (0 degrees az) and true horizontal (0 degrees el). Position indicators are positive reading devices and if rotated counterclockwise through 0 degrees will indicate 359+ degrees.

Characteristic	Specification
Azimuth servo limits	350 degrees cw, 10 degrees ccw
Azimuth electrical limits	355 degrees cw, 5 degrees ccw
Azimuth breakaway electrical connector plug limits	240 degrees (cw indication = 60 degrees; ccw indication = 300 degrees).
Elevation servo limits (nominal)	90.5 degrees up, -0.5 degrees down (359.5 degrees indication)
Elevation electrical limits	92 degrees up, -2.0 degrees down (358 degrees indicated)
Low elevation cutoff limit	7.5 degrees (nom)
Antenna control panel 14A8	
ower requirements:	
Synchro reference voltage	120 ±12 V ac, 50 ±2.5 Hz or 60 ±3.0 Hz
Indicator voltage	+26 V dc (nom)
Slew velocity excitation	±15 ±0.5 V dc
Logic voltage	+5 ±0.1 V dc
nput signals:	
Azimuth manual relay clutch enable	+26 V dc
Elevation manual relay clutch enable	+26 V dc
Standby mode status	+26 V dc
Manual mode status	+26 V dc
Slave mode status	+26 V dc
Acquisition mode status	+26 V dc
AUTOTRACK mode	+26 V dc

Table 1-3 Electrical Characteristics - Continued

Characteristic	Specification
Azimuth antenna position (syn-cx)	3-wire synchro signals at 85 V rms (max)
Elevation antenna position (syn-cx)	3-wire synchro signals at 85 V rms (max)
Azimuth servo limit status	+26 V dc
Elevation servo limit status	+26 V dc
Output signals:	
Azimuth manual (handcrank) error	Ac signal proportional to difference between handcrank and synchro positional inputs.
Elevation manual (handcrank) error	Ac signal proportional to difference between handcrank and synchro positional inputs.
Azimuth slew velocity	
Clockwise	0 to -15 V dc (nonlinear)
Counterclockwise	0 to +15 V dc (nonlinear)
Elevation slew velocity	
Up	0 to -15 V dc (nonlinear)
Down	0 to +15 V dc (nonlinear)
Standby mode command	5 V return (logic 0)
Manual mode command	5 V return (logic 0)
Slave mode command	5 V return (logic 0)
Acquisition mode command	5 V return (logic 0)
Azimuth slew command	5 V return (logic 0)
Elevation slew command	5 V return (logic 0)
Antenna position and status panel 14A7	
Power requirements:	
Demodulator reference	20 V ac
Instrument servo synchro and transformer excitation	120 ±12 V ac, 50 ±2.5 Hz or 60 ±3.0 Hz
Analog operational amplifier reference	±15 V dc
Relay/indicator voltage	+26 V dc
Logic voltage	+5 V dc
Logic levels:	
Logic 1	+5 V dc
Logic 0	0 V
Input signals:	
Azimuth antenna position (syn-cx)	85 V rms (max)
Azimuth antenna position (syn-tx)	85 V rms (max)
Elevation antenna position (syn-cx)	85 V rms (max)
Elevation antenna position (syn-tx)	85 V rms (max)
Antenna safe	+26 V dc
Azimuth slew command	5 V return (0 V)
Elevation slew command	5 V return (0 V)
Azimuth slave error	0.31 V rms (max)
Elevation slave error	0.31 V rms (max)
Azimuth tracking error	±7 V dc/degree of error
Elevation tracking error	±7 V dc/degree of error
Azimuth servo limit (CW)	+26 V dc
Azimuth servo limit (CCW)	+26 V dc
Elevation servo limit (up)	+26 V dc
Elevation servo limit (down)	+26 V dc
Azimuth electrical limit	+26 V dc
Elevation electrical limit	+26 V dc
Elevation cutoff	+5 V dc
Azimuth handcrank engaged	+26 V dc
Elevation handcrank engaged	+26 V dc
Azimuth scr failure	+26 V dc
Elevation scr failure	+26 V dc
Azimuth motor hot	+26 V dc
Elevation motor hot	+26 V dc

Table 1-3 Electrical Characteristics - Continued

Characteristic	Specification
ave source available	+26 V dc
Standby mode command	Logic 0
Manual mode command	Logic 0
Slave mode command	Logic 0
Acquisition mode command	Logic 0
Azimuth and elevation scr normal status	+26 V dc
Azimuth brakes manually released	+26 V dc
Elevation brakes manually released	+26 V dc
Signal acquired	+26 V dc
Signal detected	+26 V dc
Stow status	+26 V dc
Azimuth manual (handcrank) error	Ac signal proportional to difference between handcrank and electrical position (synchro) inputs.
Elevation manual (handcrank) error	Ac signal proportional to difference between handcrank and electrical position (synchro) inputs.
Azimuth slew velocity	0 to ±15 V dc (nonlinear)
Elevation slew velocity	0 to ±15 V dc (nonlinear)
Antenna minor drive fault status	+26 V dc
Power outputs:	
Instrument servo synchro excitation	120 V ac, 50 or 60 Hz, 1-ph
Synchro excitation	105 V ac, 50 or 60 Hz, 1-ph
Slew potentiometer excitation	±15 V dc
Relay and switch excitation	+26 V dc
Logic excitation	+5 V dc
Output signals:	
Standby mode status	+26 V dc
Manual mode status	+26 V dc
Slave mode status	+26 V dc
Acquisition mode status	+26 V dc
Autotrack mode status	+26 V dc
Azimuth manual relay clutch enable	+26 V dc
Elevation manual relay clutch enable	+26 V dc
Azimuth antenna position synchro	85 V rms (max)
Elevation antenna position synchro	85 V rms (max)
Autotrack dropout	Relay closure
Slaved	Relay closure
Azimuth servo limit status	+26 V dc
Elevation servo limit status	+26 V dc
Antenna major fault	Relay closure
Azimuth scr operate command	+26 V dc
Elevation scr operate command	+26 V dc
Autotrack mode status	Relay closure
Azimuth scr local enable	+26 V dc
Elevation scr local enable	+26 V dc
Antenna major maintenance status	Switch closure
Azimuth velocity command	10 V dc/degree of error, ±10 V dc (max)
Elevation velocity command	10 V dc/degree of error, ±10 V dc (max)
zimuth position indicator:	
Dial range	0 to 360 degrees
Type pointer	Synchro driven
Readout accuracy	Less than 1 degree readout error.
Elevation position indicator:	
Dial range	0 to 90 degrees
Type pointer	Synchro driven
Readout accuracy	Less than 1 degree readout error.

Table 1-3 Electrical Characteristics - Continued

Characteristic	Specification
Servo power supply assembly 14A9	
Power requirements:	120 ±12 V ac, 50 or 60 Hz, 1-ph
Power outputs:	
Demodulator reference voltage	20 ±2 V ac
Analog operational amplifier voltage	±15 ±0.1 V dc
Synchro reference voltage	120 ±12 V ac
Logic voltage	5 ±0.1 V dc
Relay/indicator voltage	26 ±0.13 V dc
+26 V dc power supply 14A9PS1:	
Input voltage range	105 to 125 V ac
Input frequency range	50 to 420 Hz
Output voltage range (adjustable)	24.4 to 26.8 V dc
Maximum output current	25 A
Ripple	0.01 pct or 5 mV rms, whichever is greater with 60 Hz input.
Regulation (line and load combined)	±0.5 pct
+15 V dc power supply 14A9PS2:	
Input voltage range	105 to 132 V ac
Input frequency range	45 to 440 Hz
Output voltage range	15 V dc ±5 pct
Maximum output	2.2 A
Ripple	1 mV rms, 3 mV peak-to-peak
Regulation:	
Line	Less than 0.05 pct plus 4.0 mV for input variations from 105 to 132 V ac.
Load	Less than 0.03 pct plus 3.0 mV for load variations from 0 to full load.
-15 V power supply 14A9PS3:	
Input voltage range	105 to 132 V ac
Input frequency range	45 to 440 Hz
Output voltage range	-15 V dc +5 pct
Maximum output current	2.2 A
Ripple	1 mV rms, 3 mV peak-to-peak
Regulation:	
Line	Less than 0.05 pct plus 4.0 mV for input variations from 105 to 132 V ac.
Load	Less than 0.03 pct plus 3.0 mV for load variations from 0 to full load.
+5 V power supply 14A9PS4:	
Input voltage range	105 to 132 V ac
Input frequency range	45 to 440 Hz
Output voltage range	5 V dc ±5 pct
Maximum output current	5.1 A
Ripple	1 mV rms; 3 mV peak-to-peak
Regulation:	
Line	Less than 0.05 pct plus 4.0 mV for input variations from 105 to 132 V ac.
Load	Less than 0.03 pct plus 3.0 mV for load variations from 0 to full load.

R14 and at a specific point overcomes the preset voltage reference, at which time Q3 conducts. Conduction of current limit amplifier Q3 results in decreased conduction of driver Q5. Decreased conduction of driver Q5 causes a less positive potential to be developed across resistor R22 and consequently causes a reduction in the forward bias of series regulator Q8. As a result, the emitter-collector impedance of Q8 is increased, reducing the output voltage lower than the initial drop due to the overload, effectively limiting the output current to a safe value. When operating conditions approach short circuit, the output voltage decreases. Since the voltage determined by potentiometer R17 and resistor R18 is proportional to the output voltage, current limit amplifier Q3 is successively biased into turnon at lower and lower load currents as the output voltage decreases. This action permits the current limit amplifier to turn on at lower and lower load currents until output voltage decreases to zero and current decreases to a predetermined low value.

2-17. +5 V DC Power Supply 14A9PS4 Circuit Analysis (fig. FO-15). The +5 V dc power supply provides a regulated +5 V dc output at 5.1 A and contains protective circuits for overcurrent conditions. The +5 V dc power supply consists of an ac input circuit, a main rectifier, a bias supply, and a series voltage regulator circuit.

a. Ac Input Circuit. Single phase 120 V ac input power is applied to transformer T1. Transformer T1, which contains two secondary windings, steps down the input voltage for application to the main and auxiliary rectifiers.

b. Bias Supply. The bias supply, consisting of half-wave auxiliary rectifier CR7, filter capacitor C7, and zener diode regulator CR6, provides operating voltage for error amplifiers Q1 and Q2 and current limit amplifier Q3. Zener diode CR1 and resistor R5, which are connected across the bias supply, provide a regulated temperature compensated reference voltage. Resistor R4 compensates for input voltage variations.

c. Main Rectifier. The main rectifier consists of rectifiers CR9 and CR11 and filter capacitor C8. The rectifiers perform full wave rectification of the ac voltage from transformer T1 to provide a dc voltage that is filtered by capacitor C8. The filtered dc voltage is applied to series regulator Q8.

d. Series Voltage Regulator Circuit. The series voltage regulator circuit regulates the dc output voltage and provides overcurrent protection. The series voltage regulator circuit is composed of error amplifiers Q1 and Q2, current limit amplifier Q3, driver Q5, and series regulator Q8. Series regulator Q8 receives dc voltage from the main rectifier and controls the output by presenting a variable impedance in series with the load. The regulated 5 V dc output is taken across pins 6 and 4 of terminal board TB1. The dc output voltage is adjustable from 4.75 V dc to 5.25 V dc by potentiometer R1. Series regulator Q8, which regulates the dc output voltage to the adjustable value established by potentiometer R1, is controlled by signals derived from error amplifiers Q1 and Q2 or current limit amplifiers Q3. Error amplifiers Q1 and Q2 provide the control signal under normal load conditions and current limit amplifier Q3 provides the control signal during overload conditions.

(1) ***Normal load regulation.*** Operation of the series regulator circuit is determined by changes in the output voltage. A change in output voltage is sensed by sensing divider resistors R2 and R3 and potentiometer R1, which compare output voltage with the + sense (+S) reference voltage. The +S reference voltage is established by zener diode CR1 and resistor R5. Comparison of the output voltage with the +S reference voltage produces an error voltage at the junction of resistors R2 and R3, which is amplified by error amplifiers Q1 and Q2 and current amplified by driver Q5. The corresponding change in driver Q5 emitter current drives the emitter-base junctions of series regulator Q8. This action increases the emitter-to-collector voltage drop of series regulator Q8 to decrease the output voltage if the output voltage has increased, and decreases the emitter-to-collector drop to increase the output voltage if the output voltage has decreased.

(2) ***Overcurrent operation.*** In the event of a large increase in load current, current limit amplifier Q3 takes over regulation control at a specific point and effectively current-regulates the output. Operation of current limit amplifier Q3 is controlled by a preset voltage reference applied to the base junction and a voltage applied to the emitter junction, which is proportional to output load current. The preset voltage reference is developed by the voltage divider composed of potentiometer R17 and resistor R18. The current limit value is determined by the factory setting of potentiometer R17. The output load current is sampled by resistor R28, which is in series with the output current path. Under normal load conditions, current limit amplifier Q3 is held cut-off by the preset reference voltage. A large increase in load current produces increased forward bias for Q3 developed by resistor R28 and at a specific point overcomes the preset voltage reference, at which time Q3 conducts. Conduction of current limit amplifier Q3 results in decreased conduction of driver Q5. Decreased conduction of drivers Q5 and Q6 causes a less positive potential to be developed across resistor R22 and consequently causes a reduction in the forward bias of series regulator Q8. As a result, the emitter-collector impedance of Q8 is increased, reducing the output voltage lower than the initial drop due to the overload, effectively limiting the output current to a safe value. When operating conditions approach short circuit, the output voltage decreases. Since the voltage determined by potentiometer R17 and resistor R18 is proportional to the output voltage, current limit amplifier Q3 is successively biased to turn-on at lower and lower load currents as the output voltage decreases. This action per-

mits the current limit amplifier to turn on at lower and lower load currents until output voltage decreases to zero and current decreases to a predetermined low value.

SECTION V. CIRCUIT ANALYSIS OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24

2-18. Assembly Circuit Analysis (fig. FO-16). Stow pin control/minor fault summary panel HTA-8A24 provides local control and monitoring of certain antenna functions. Dc operating power is supplied by +26 V dc power supply PS1. The power supply is sealed and is nonrepairable. The unit contains a voltage adjust locking potentiometer. Once set, no further adjustment should be required. The power supply receives 120 V, 60 Hz through J1 and circuit breaker CB1. The other functions are discussed below.

2-19. Rain Deflector Switch HTA-8A24S5 (fig. FO-16, sh 1). The rain deflector circuit is operated from alternate action pushbutton indicator switch S5. Pressing RAIN DEF ON switch S5 applies a 26 V dc rain deflector on command through the deenergized contacts of relay K16, to J3 pin N. This command is then applied to an external relay as an energizing voltage, causing the RAIN DEF ON indicator to light white. Relay K16 on the stow pin control/minor fault summary panel provides a rain deflector interlock, removing the rain deflector on command signal from the external relay whenever the low nitrogen pressure indicator is lighted. This prevents damage to the feed cover membrane due to flutter caused by the rain deflector air stream.

2-20. Maintenance Switch HTA-8A24S6 (fig. FO-16, sh 1). Maintenance switch S6 is an alternate action pushbutton indicator switch. Pressing the switch to the on position applies 26 V dc to light the MAINTENANCE indicator blue and to provide an antenna minor maintenance signal through J4 to system status logic unit 15A5.

2-21. Minor Drive Fault Circuit (fig. FO-16, sh 2). The minor drive fault circuit contains relays and indicators to provide a front panel display of low oil pressure for any speed reducer gear assembly or a fuse failure in direct current control HTA-9. The six normally closed relay inputs apply 26 V dc excitation voltage to energize stow pin control/minor fault summary panel relays. The energized relays then remove 26 V dc from the indicators to extinguish them. When a fault occurs, the relay opens, deenergizing the panel relay and lighting the indicator amber to identify the fault. The second set of relay contacts for the four speed-reducer gear assembly oil flow sensors and two scr assembly fuse circuits are series-connected to minor drive fault relay K10. This relay is energized by 26 V dc applied through the six contact sets and provides a contact closure externally to indicate a minor drive fault should any monitored relay open. Relay K15 prevents a minor drive fault indication when an scr operate command is lost.

2-22. Minor Fault Summary Circuit (fig. FO-16, s 2). The minor fault summary circuit contains relays a indicators to provide a front panel display of air cond tioner temperature status, overtemperature status of t high pass transmit filter in the feed group, and feed gro nitrogen pressure status. The minor fault summary c cuit relays operate in the same manner as the minor dri fault relays (subpara 2-21 above). In addition, the min fault summary relay contacts, when energized, are seri connected to minor drive fault status relays to apply exc tation to minor fault summary relay K11. When deener ized, these relays provide a contact closure externally indicate a fault. Thus, any minor drive fault will be su marized with minor fault summary faults and will ther fore produce both an antenna minor drive fault stat signal and an antenna minor fault summary status sign

2-23. Stow Pin Control (fig. FO-16, sh 1). Tw identical relay and switch circuits are used for azimu and elevation stow pin control. Only the azimuth circ is discussed. The antenna azimuth axis, when aligned the proper position for insertion of the azimuth stow p actuates the external azimuth axis aligned switch to pr vide 26 V dc to azimuth STOW and RETRACT pushbu ton indicator switches. The azimuth axis aligned swit thus prevents activation of the stow function at other th the proper position. Assuming the stow pin is retracte the switch in the linear electromechanical actuator closed, providing 26 V dc to energize azimuth retra relay K9 and illuminate the AZIMUTH RETRACT i dicator. Pressing the AZIMUTH STOW switch provid the azimuth stow command signal to the stow pin actu tor and a stow signal to system status logic unit 15A5. T stow pin, in moving from the retract position, opens t AZIMUTH RETRACT switch to denergize K9 and tu off the RETRACT indicator. Since the stow pin is not y in position, the stowed switch is also open and K8 deenergized. The AZIMUTH IN TRANSIT indica lights with both K8 and K9 deenergized to indicate t stow pin is between the stow and retract positions. Wh the stow pin becomes fully engaged in the stow positi the stowed switch closes to energize K8, turn off t AZIMUTH IN TRANSIT indicator, and light the A IMUTH STOW indicator. The procedure for retracti the stow pin is similar when the azimuth retract comm is provided by the AZIMUTH RETRACT switch.

Table 1-3 Electrical Characteristics - Continued

Characteristic	Specification
Regulation:	
Line	Less than 0.05 pct plus 4.0 mV for input variations from 105 to 132 V ac.
Load	Less than 0.03 pct plus 3.0 mV for load variations from 0 to full load.
Az/El Antenna Drive Assy 1 and 2, HTA-12A1 through 12A4	
Subassembly details:	
Dc drive motor:	
Horsepower	10 hp
Rated speed	2300 r/min (60 Hz); 1750 r/min (50 Hz)
Power requirements:	
Voltage (field and armature)	240 V dc
Armature current	34.3 A (full load)
Field current	1.12/.77A (Full load, rated speed)
Circuit resistance	
Armature:	.239 ohms
Field:	153 ohms
Armature inductance	5.9 millihenries
Armature inertia	3.31 lb-ft
Torque constant	0.926 lb-ft/A
Speed constant	1.25 V sec/radian max
Thermal overload switch	Normally closed
Dc tachometer-generator	
Rated speed	100-3600 r/min (either direction)
Output voltage	100 V/1000 r/min ± 1% to 1750 r/min.
Current rating	0.10 A
Internal resistance (25 deg C)	18.9 ohms
Voltage ripple	0.5 pct, 100 to 1750 r/min.
Inertia	6 $lb\text{-}in^2$
Breakaway torque	26 oz-in
Electric disk brake	
Torque	75 lbs-ft
Power requirements	208 V rms
Type of brake operation	Spring set, electrically released and reset
Type of brake disks	Friction disks, self-adjusting for wear
Ac blower motor	
Power requirements	208 V rms
Current	1.1 A
Rated Speed	3450 r/min (60 Hz), 2875 r/min (50 Hz)
Horsepower	1/3 hp
Assembly inputs (typical)	
Drive power	+240 V dc (max)
Motor field power	+240 V dc
Blower motor operate power	120/208 V ac, 3-ph, 4 wire
Brake power	208 V rms
Output signals:	
Azimuth brakes manual release interlock	+26 V dc
Elevation brakes manual release interlock	+26 V dc
Azimuth motor hot	+26 V dc
Elevation motor hot	+26 V dc
Azimuth motor 1/2 current feedback	22 mA
Elevation motor 1/2 current feedback	22 mA
Azimuth dc tachometer-generator 1/2 velocity feedback	100 V/1000 r/min
Elevation dc tachometer-generator 1/2 velocity feedback	100 V/1000 r/min
Azimuth oil pumps operate command	+26 V dc
Elevation oil pumps operate command	+26 V dc

Table 1-3 Electrical Characteristics - Continued

Azimuth and elevation data modules HTA-8A7/6A6

Characteristic	Specification
Power requirements (typical):	
Synchro reference	100 V ac (nominal), 50 or 60 Hz
Inputs:	
Mechanical	Azimuth and elevation shafts slaved to antenna axial rotation
Output signals:	
Azimuth servo limit CW/CCW	+26 V dc
Elevation servo limit up/down	+26 V dc
Azimuth electrical limit	+26 V dc
Elevation electrical limit	+26 V dc
Low elevation cutoff interlock (elevation data module only)	Switch closure
Azimuth antenna position (syn-cx) (each synchro)	85 V rms (max)
Elevation antenna position (syn-cx) (each synchro)	85 V rms (max)
Azimuth antenna position (syn-tx) (each synchro)	85 V rms (max)
Elevation antenna position (syn-tx) (each synchro)	85 V rms (max)

Antenna safe switch HTA-4A7, 6A9, 8A10, 8A27

Input signals:	
Antenna safe	+26 V dc
Antenna operate	+26 V dc
Output signals:	
Antenna safe	0 V
Antenna operate	+26 V dc

Reflector door switch HTA-2A1S1

Input signal:	
Low elevation cutoff interlock	Switch closure (+5 V dc logic)
Output signal:	
Low elevation cutoff/reflector door closed	Switch closure (+5 V dc logic)

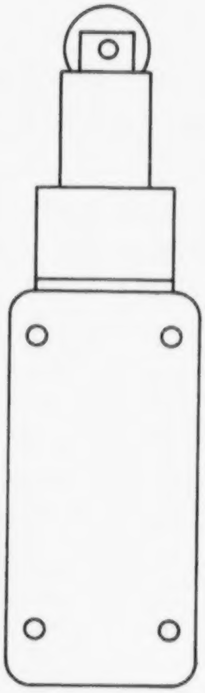
c. Cross-Reference Index. Table 1-4 provides a cross-reference index of equipment reference designations and functional group number (FGN) assignments as they apply to Maintenance Allocation Charts (MA and Repair Parts and Special Tools Lists (RPSTL).

Table 1-4 Cross-Reference Index

Ref des	Common name	FGN
HTA-2A1S1	Reflector door switch	
HTA-4A7, 6A9,6A10,	Antenna safe switch	0201
HTA-6A6A1	Elevation data module	0208
HTA-6A6A1S1	Limit switch	020801
HTA-8A7	Azimuth cable wrap and data module assembly	0203
HTA-8A7A1	Azimuth data module	0210
HTA-8A7A1S1	Rotary switch	021001
HTA-8A24	Stow pin control/minor fault summary panel	0206
HTA-8A24PS1	+26 V dc power supply	020601
HTA-9	Direct current control	0207
HTA-9A1	Power supply control	020701
HTA-9A1PS1	+5 V dc power supply	02070101
HTA-9A1PS2	Dual 15 V dc power supply	02070102
HTA-9A1PS3	+15 V dc gate power supply	02070103
HTA-9A2 and HTA-9A3	Electronic control amplifier	020702
HTA-9A2A1, HTA-9A3A1	Amplifier subassembly card	02070201
HTA-9A2A2 through 9A2A7, 9A3A2 through 9A3A7	Scr assembly	02070202
HTA-9L1	Power inductor	020703
HTA-12	Antenna ancillary group	0202
HTA-12A1 through 4	Drive motor assembly	0211
HTA-12A1A1 through A4A1	Electric disk brake	021102
HTA-12A1B1 through A4B1	Dc motor	021105
HTA-12A1B2 through A4B2	Motor blower	021103
HTA-12A1G1 through A4G1	Dc tachometer-generator	021101
HTA-12A1MP5 through A4MP5	Junction box	021104
HTA-12A1MP61 through A4MP61	Conduit assembly	021106
HTA-12A1MP-61MP95	Electronic components assembly	02110601
14A7	Antenna position and status panel	0209
14A7A1	Mode logic circuit card assembly	020901
14A7A2 and 14A7A3	Servo analog circuit card assembly	020902
14A7A4 through 14A7A7	Relay circuit card assembly	020903
14A7A8	Electrical equipment chassis	020906

Table 1-4 Cross-Reference Index - Continued

Ref des	Common name	FGN
14A7A8A1	Back plane connector assembly	02090601
14A7DS1	Elevation antenna position indicator	020904
14A7DS2	Azimuth antenna position indicator	020905
14A8	Antenna control panel	0204
14A8A1,A2	Instrument servo assembly	020401
14A8A1AR1 and A2AR1	Synchro signal amplifier	02040101
14A8A1A1 and A2A1	Electronic component assembly	02040103
14A8A1B1 and A2B1	Control motor	02040104
14A8A1M1 and A2M1	Decimal counter	02040102
14A8A1PS1 and A2PS1	Power supply	02040105
14A9	Servo power supply assembly	0205
14A9PS1	+26 V dc power supply	020501
14A9PS2	+15 V dc power supply	020502
14A9PS3	-15 V dc power supply	
14A9PS4	+5 V dc power supply	020503



EL5895-915-34-TM-10

Figure 1-10. Reflector door switch HTA-2A1S1.

CHAPTER 2
FUNCTIONING OF EQUIPMENT

SECTION I. FUNCTIONAL ANALYSIS OF SERVO AND CONTROL EQUIPMENT GROUP

2-1. Introduction. This chapter provides functional descriptions of the servo and control equipment as an aid to understanding the maintenance instructions in chapters 3 and 4. Servo and control equipment group functions and their relationship to each item of equipment are described in section I. Section I also includes detailed discussions of the operating modes and the servo loop. Sections II through IX provide circuit analyses of each of the servo and control equipment units.

2-2. Servo Control (fig. 2-1). Servo control is provided by mode switches and indicators on antenna control panel 14A8 and logic in antenna position and status panel 14A7. Depending on the mode selected, error signals from slave equipment, Control-Indicator ID-1911/G (tracking receiver control and status panel 14A6), or antenna control panel 14A8 are processed by the antenna position and status panel and, if no major fault condition exists in the servo and control equipment, are passed to direct current control HTA-9 as velocity command signals. Major faults are discussed in paragraph 2-7. The mode control/status signal is applied to the antenna control panel to light the mode display. The direct current control processes the velocity command signals and provides antenna drive power to the drive motors in antenna ancillary group HTA-12. Local controls in direct current control HTA-9 may also be used to provide velocity command signals for antenna drive power generation. Antenna movement is sensed by data module synchros in both axes. The synchros provide positional feedback to the control circuits.

*a. **Antenna Position Feedback.*** The azimuth and elevation data modules are mechanically coupled to the respective antenna axis. Antenna movement, which is sensed by gears in the azimuth and elevation data modules, is converted to positional data by synchro transmitters. The antenna position signal is applied to synchro receivers in antenna position and status panel 14A7, and through the antenna position and status panel to synchro receivers in antenna control panel 14A8 instrument servo assemblies. The antenna position and status panel displays approximate antenna angles in both axes. The antenna control panel displays exact (to ±0.02 degrees) antenna angles. The operator uses the angular readouts to determine operating speeds and other control requirements.

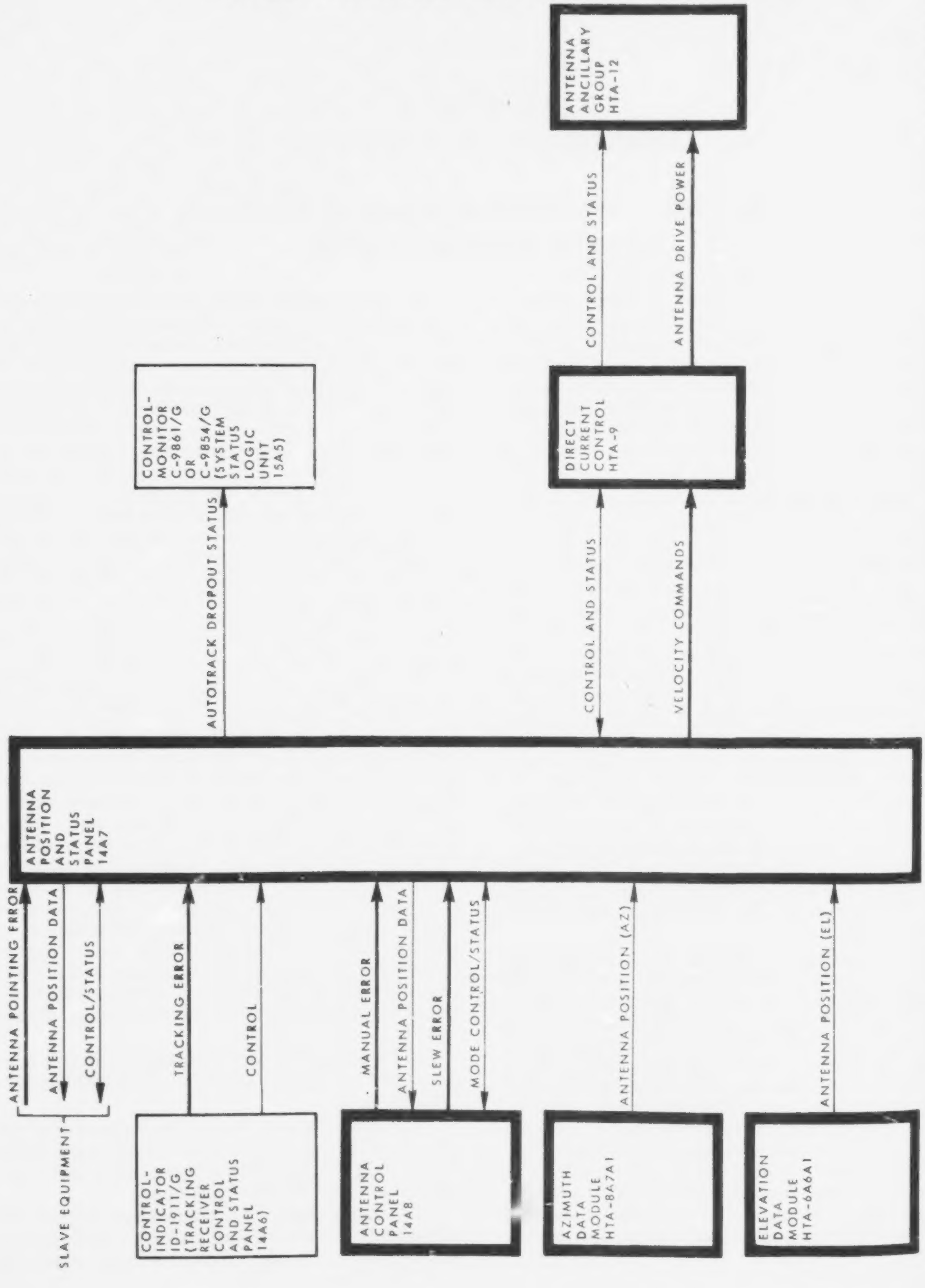
*b. **Mode Control.*** When manual mode is selected, the handcranks on antenna control panel 14A8 may be used to generate manual error signals, or the SLEW controls may be used to generate slew error signals. When the slave mode is selected and a slave available control/status signal is received by antenna position and status panel 14A7, the servo and control equipment is slaved to the remote equipment. In the slave mode, antenna position data is transmitted from the antenna position and status panel to the slave source and all antenna movement is remotely controlled by predetermined antenna pointing error signals. When autotrack mode is selected, and control signals from tracking receiver control and status panel 14A6 are compatible with servo electronics, the antenna responds automatically to the external tracking error signals. Tracking error and control signals are monitored by mode electronics. If the control signals are not present, an autotrack dropout status signal is output to system status logic unit 15A5. A detailed analysis of the servo control loop is provided in paragraph 2-8.

2-3. Major Faults Monitor and Display (fig. 2-2). Any condition in the servo and control equipment which could cause injury to personnel, damage to equipment, or major outage is interpreted by circuits in antenna position and status panel 14A7 as a major fault status signal. Major fault and maintenance status signals are displayed by the antenna position and status panel STATUS indicators and a major fault status signal is output to system status logic unit 15A5. The system status logic unit issues a major alarm (sonalert). The alarm can be silenced by pressing the MAINT indicator switch on the antenna position and status panel. The maintenance circuit provides a major maintenance status signal directly to the system status logic unit. Major faults are summarized as follows.

*a. **Power Failure.*** Any power supply failure in servo power supply assembly 14A9 lights the POWER FAILURE indicator.

*b. **Antenna Stowed.*** When either the azimuth or elevation stow pin is in stow position, stow pin control/minor fault summary panel HTA-8A24 provides a stow status signal that lights the STOW indicator.

*c. **Antenna Limits.*** When the antenna is driven into any azimuth or elevation limit position, a servo prelimit signal is applied from the respective azimuth or elevation


SLAVE EQUIPMENT
ANTENNA POINTING ERROR
ANTENNA POSITION DATA
CONTROL/STATUS
CONTROL-INDICATOR ID-1911/G (TRACKING RECEIVER CONTROL AND STATUS PANEL 14A6)
TRACKING ERROR
CONTROL
ANTENNA CONTROL PANEL 14A8
MANUAL ERROR
ANTENNA POSITION DATA
SLEW ERROR
MODE CONTROL/STATUS
AZIMUTH DATA MODULE HTA-8A7A1
ANTENNA POSITION (AZ)
ELEVATION DATA MODULE HTA-6A6A1
ANTENNA POSITION (EL)
ANTENNA POSITION AND STATUS PANEL 14A7
AUTOTRACK DROPOUT STATUS
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
CONTROL AND STATUS
VELOCITY COMMANDS
DIRECT CURRENT CONTROL HTA-9
CONTROL AND STATUS
ANTENNA DRIVE POWER
ANTENNA ANCILLARY GROUP HTA-12

EL5895-915-34-TM-81

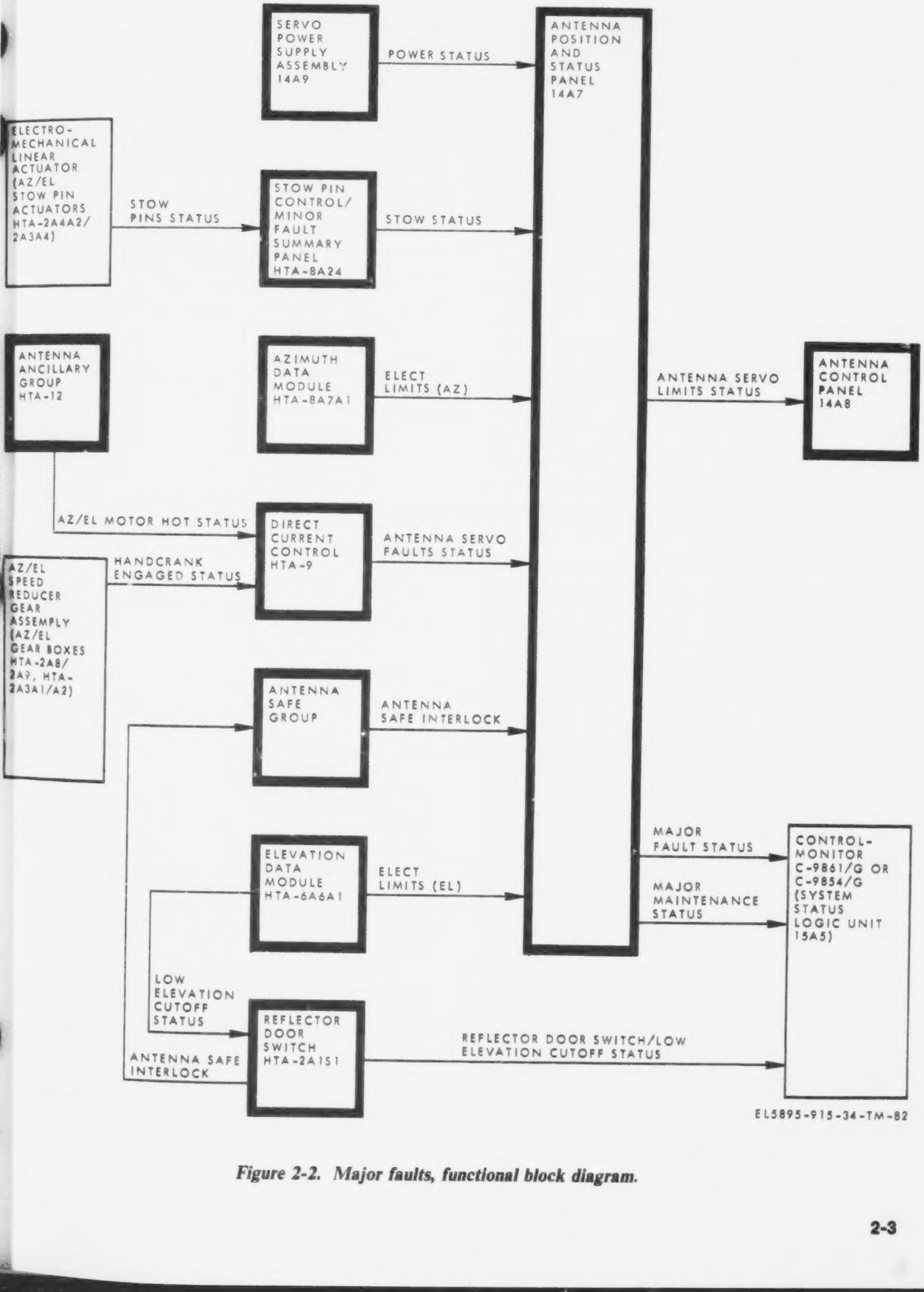

SERVO POWER SUPPLY ASSEMBLY 14A9
POWER STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
ELECTRO-MECHANICAL LINEAR ACTUATOR (AZ/EL STOW PIN ACTUATORS HTA-2A4A2/2A3A4)
STOW PINS STATUS
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
STOW STATUS
ANTENNA ANCILLARY GROUP HTA-12
AZIMUTH DATA MODULE HTA-8A7A1
ELECT LIMITS (AZ)
ANTENNA SERVO LIMITS STATUS
ANTENNA CONTROL PANEL 14A8
AZ/EL MOTOR HOT STATUS
DIRECT CURRENT CONTROL HTA-9
ANTENNA SERVO FAULTS STATUS
HANDCRANK ENGAGED STATUS
AZ/EL SPEED REDUCER GEAR ASSEMPLY (AZ/EL GEAR BOXES HTA-2A8/2A9, HTA-2A3A1/A2)
ANTENNA SAFE GROUP
ANTENNA SAFE INTERLOCK
MAJOR FAULT STATUS
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
ELEVATION DATA MODULE HTA-6A6A1
ELECT LIMITS (EL)
MAJOR MAINTENANCE STATUS
LOW ELEVATION CUTOFF STATUS
REFLECTOR DOOR SWITCH HTA-2A1S1
REFLECTOR DOOR SWITCH/LOW ELEVATION CUTOFF STATUS
ANTENNA SAFE INTERLOCK
EL5895-915-34-TM-82

Figure 2-2. Major faults, functional block diagram.

data module to antenna position and status panel 14A7. This is not a major fault. Analog circuits in the antenna position and status panel apply reversing voltages to the servo electronics and light the AZ/EL SERVO LIMIT indicator on antenna control panel 14A8. Further antenna driving in the same direction will cause an electrical limit signal to be applied from the azimuth or elevation data module to the antenna position and status panel. An electrical limit is a major fault and is displayed on the antenna position and status panel as AZ/EL ELECT LIMIT. An electrical limit condition also removes servo drive power and the antenna must be backed-out of the limit with the handwheels on Azimuth/Elevation Speed Reducer Gear Assembly (az/el gear boxes HTA-2A8,2A9 and HTA-2A3A1,A2). Refer to TM 11-5895-900-34 for details of the handcranks.

d. Motor Overheat/Handcrank Engaged. A motor hot status signal from any of the four motors in antenna ancillary group HTA-12 or a handcrank engaged status signal from any of the four az/el gear boxes (HTA-2A8,2A9 and HTA-2A3A1,2A3A2) is applied through direct current control HTA-9 to antenna position and status panel 14A7. AZ/EL MOTOR HOT and HANDCRANK ENGAGED STATUS indicators display the respective fault or condition. A handcrank engaged condition is interpreted by the antenna position and status panel circuits as a major fault.

e. Brakes Manually Released. A brakes manually released signal from any one of four electric disk brakes in the antenna ancillary group is monitored by direct current control HTA-9 and passed to antenna position and status panel 14A7. The BRAKES MANUALLY RELEASED STATUS indicator displays the condition, which the antenna position and status panel interprets as a major fault.

f. Direct Current Control Failure. Scr fail logic in direct current control HTA-9 monitors and displays local faults, summarizes them into an scr fail signal and passes the signal to antenna position and status panel 14A7. The SCR FAILURE STATUS indicator displays the fault.

g. Antenna Safe. An antenna safety interlock is provided by antenna safe switches HTA-4A7,6A9,8A10,8A27, one contact of reflector door switch HTA-2A1S1, breakaway electrical connector plug HTA-P201, and antenna position and status panel key switch 14A7S1. If any of these interlocks are broken, the SAFE STATUS indicator lights and a major fault status is signaled.

h. Radio Frequency Cutoff. An rf safety interlock is provided by a segment of elevation data module HTA-6A6A1 limit switch and a contact of reflector door switch HTA-2A1S1. If either of the switches is opened, a reflector door switch/low elevation cutoff signal is provided to system status logic unit 15A5. The system status logic unit detects the signal and compares it with other inputs to determine if a major fault status is indicated. If a major fault status is indicated, the system status logic unit sends an rf cutoff command to transmitter equipment. In either case, the signal has no electrical effect on the servo and control equipment.

2-4. Stow and Rain Deflector Control and Minor Faults Monitor and Display (fig. 2-3). Stow pin control/minor fault summary panel HTA-8A24 provides control of the Linear Electromechanical Actuators (azimuth/ elevation stow pin actuators HTA-2A4A2,2A3A4) and the rain deflector blower in Feed Assembly AS-2941/FSC (feed assembly HTA-1A1) Minor drive faults are monitored by stow pin control minor fault summary panel HTA-8A24, which displays each fault and summarizes the faults for external monitoring. Following is a description of the control functions monitor inputs, and summary outputs.

a. Stow Control. Stow and retract commands are issued from manual controls on stow pin control/minor fault summary panel HTA-8A24. When the azimuth stow pins are retracted, for example, and the azimuth stow pin is aligned with a stow pin hole, a stow pin aligned status signal from the push switch (azimuth stow pin aligned switch HTA-2A4A1) is summed with AZIMUTH STOW switch output to provide a stow control to azimuth stow pin actuator HTA-2A4A2.

b. Rain Deflector Control/Status. A rain deflector control/status signal from stow pin control/minor fault summary panel HTA-8A24 is applied to Rain Deflector Distribution Box (rain deflector power distribution box HTA-1A5). The rain deflector power distribution box applies ac power to the rain deflector blower motor and provides a status signal to the stow pin control/minor fault summary panel.

c. Minor Drive Fault Status. Oil pressure status is monitored by azimuth and elevation gear boxes HTA-2A8,2A9 and HTA-2A3A1,3A2. If the oil pressure drops below a preset limit, an oil pressure status signal is applied through direct current control HTA-9 to stow pin control/minor fault summary panel HTA-8A24. The scr fuses in the direct current control are monitored locally and scr fuse status for each axis is applied to the stow pin control/minor fault summary panel. The panel sums the oil pressure status and scr fuse status signals, displays a fault, and provides a minor drive fault status to antenna position and status panel 14A7. The antenna position and status panel MINOR DRIVE FAULT STATUS indicator displays the fault.

d. Minor Fault Summary Status. The ambient temperature status of feed assembly HTA-1A1 high pa transmit filter FL1 and the ambient temperature status of thermal relay assembly HTA-2A5A2 are combined i distribution box HTA-8A25. The signal is applied t monitor circuits in stow pin control/minor fault summary panel HTA-8A24. A nitrogen pressure status signal from low pressure control panel HTA-8A31 is also applied t the monitor circuits. The monitor circuits display th

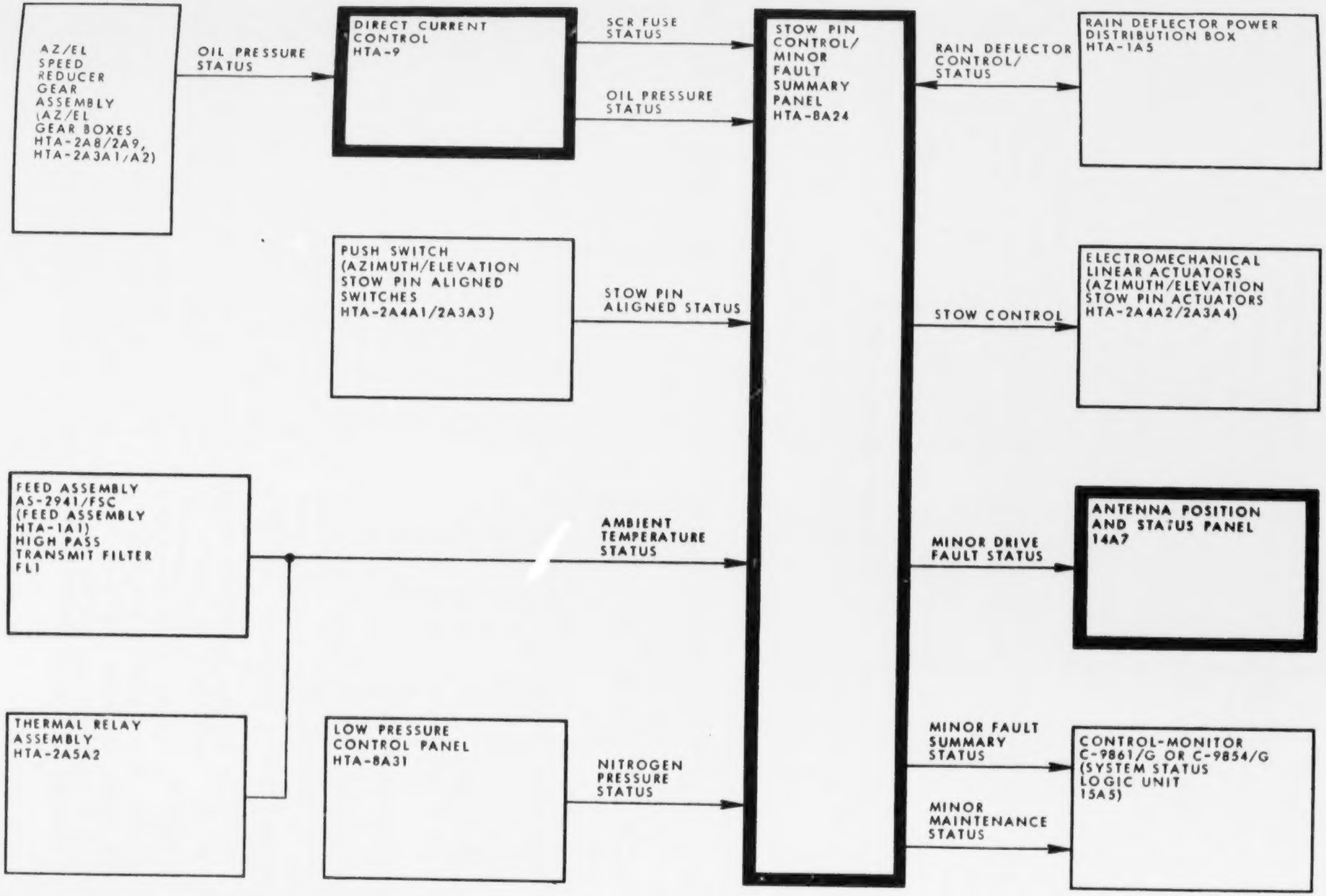

AZ/EL SPEED REDUCER GEAR ASSEMBLY (AZ/EL GEAR BOXES HTA-2A8/2A9, HTA-2A3A1/A2)
OIL PRESSURE STATUS
DIRECT CURRENT CONTROL HTA-9
SCR FUSE STATUS
OIL PRESSURE STATUS
STOW PIN CONTROL/ MINOR FAULT SUMMARY PANEL HTA-8A24
RAIN DEFLECTOR CONTROL/ STATUS
RAIN DEFLECTOR POWER DISTRIBUTION BOX HTA-1A5
PUSH SWITCH (AZIMUTH/ELEVATION STOW PIN ALIGNED SWITCHES HTA-2A4A1/2A3A3)
STOW PIN ALIGNED STATUS
STOW CONTROL
ELECTROMECHANICAL LINEAR ACTUATORS (AZIMUTH/ELEVATION STOW PIN ACTUATORS HTA-2A4A2/2A3A4)
FEED ASSEMBLY AS-2941/FSC (FEED ASSEMBLY HTA-1A1) HIGH PASS TRANSMIT FILTER FL1
AMBIENT TEMPERATURE STATUS
MINOR DRIVE FAULT STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
THERMAL RELAY ASSEMBLY HTA-2A5A2
LOW PRESSURE CONTROL PANEL HTA-8A31
NITROGEN PRESSURE STATUS
MINOR FAULT SUMMARY STATUS
MINOR MAINTENANCE STATUS
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
EL5895-915-34-TM-83

Figure 2-3. Stow control and minor faults summary circuits, functional block diagram.

fault and the status signals, which are summed with the minor drive fault status to provide a minor fault summary status output to system status logic unit 15A5. The system status logic unit issues a minor alarm (sonalert). The alarm can be silenced by pressing the MAINTENANCE indicator switch on the stow pin control/minor fault summary panel. The maintenance circuit provides a minor maintenance status output to the system status logic unit.

2-5. Power Distribution (fig. 2-4). Servo and control equipment receives input power from two sources. Control power is supplied by Communication Control Console OJ-356/G (AN/FSC-78(V)) or OJ-362/FSC-79 (AN/FSC-79) (control console unit 14). Drive power and stow pin control/minor fault summary power are supplied by ac distribution box HTA-8A26.

a. Control Power. The 120 V ac, 50/60 Hz console distribution power is distributed by control console unit 14 to servo power supply assembly 14A9. The servo power supply provides 120 V ac and 20 V ac to antenna position and status panel 14A7. The antenna position and status panel passes the 120 V ac to antenna control panel 14A8, steps the voltage down to 100 V (nominal), and distributes it to servo and control equipment synchros for reference. The 20 V ac power is used by the antenna position and status panel servo analog circuits. The servo power supply assembly distributes +26 V dc to the antenna position and status panel and direct current control HTA-9. The +26 V dc is passed by the antenna position and status panel to antenna control panel 14A8. The servo power supply assembly also distributes +15 V dc -15 V dc, and +5 V dc to control circuits in the antenna position and status panel.

b. Drive Power. Direct current control HTA-9 receives 277/480 V ac, 50/60 Hz, 3-ph, and 120/208 V ac, 50/60 Hz, 3-ph power from ac distribution box HTA-8A26. The 277/480 V ac is rectified by the direct current control and used to supply antenna ancillary group drive motor power. The 120/208 V ac is used for internal power and is distributed to antenna ancillary group for brake control.

c. Stow Control-Minor Fault Summary Power. The 120 V ac, 50/60 HZ, 1-ph power from ac distribution box HTA-8A26 is distributed to a power supply in stow pin control/minor fault summary panel HTA-8A24. The power supply distributes +26 V dc to internal buses.

2-6. Servo and Control Equipment Operating Modes (fig. FO-2). The servo and control equipment functions as a closed servo loop with five selectable modes of operation to control positioning of the antenna. The five modes of operation are standby, manual, acquisition, autotrack, and slave. The following paragraphs provide a functional description of each of the modes of operation.

a. Standby Mode. The standby mode is automatically enabled by the mode logic in antenna position and status panel 14A7 at the end of a servo and control equipment startup sequence if no fault exists. If a fault exists all modes are inhibited and the fault status logic provides a deenergizing signal to a fault relay which provides a fault signal to system status logic unit 15A5. The standby mode is also manually selectable at antenna control panel 14A8 if the servo equipment is in an operating mode. The manual mode may only be selected from the standby mode. When the STANDBY MODE pushbutton indicator switch on the antenna control panel is pressed, or when an automatic enabling signal is present, a standby mode command is applied to the standby mode logic in the antennna position and status panel. The standby mode logic inhibits the scr operate command and controls relay operation, to provide standby mode status to the antenna control panel and to prevent application of error signals to the servo analog circuit card assembly. With the scr operate command inhibited, direct current control HTA-9 removes the brake control voltage from each of the antenna drive assembly electric disk brakes, causing the brakes to be set. With the brakes set, antenna movement is prevented.

b. Manual Mode. The manual mode is selectable only when the servo and control equipment is in the standby mode. It is entered automatically from the slave and acquisition modes. The standby, slave, and acquisition modes are selectable from the manual mode.

(1) ***Manual mode selection.*** Selection of the manual mode is accomplished with the MANUAL MODE pushbutton indicator switch on the antenna control panel. When the MANUAL MODE switch is pressed, a manual mode command is applied to the manual mode logic circuit card assembly in antenna position and status panel 14A7. The manual mode command inhibits the standby mode, thus enabling the scr operate command. In addition, status signals are monitored by the fault status and interlock circuits in the antenna position and status panel. If no fault conditions exist, the fault status and interlock circuits (para 2-7) energize relays to provide an scr local enable signal for each axis. The enable signal also inhibits the fault signal to the mode logic circuit card assembly. The mode logic circuit card assembly monitors the fault signal, and if no fault conditions exist, relays are enabled to provide a manual mode status to antenna control panel 14A8 and to allow application of the manual or slew error signal to the servo analog circuit card assembly 14A7A or 14A7A3. The scr local enable signal for both axes, conjunction with the scr operate command, enables operation of the direct current control.

(2) ***Manual mode antenna positioning.*** Positioning of the antenna in the manual mode is accomplished with the azimuth and elevation handcranks or slew controls on antenna control panel 14A8.

(a) ***Handcrank operation.*** In the manual mode, mode logic circuit card assembly 14A7A1 provides a manual relay/clutch enable signal to the instrument servo assembly on antenna control panel 14A8. The man-

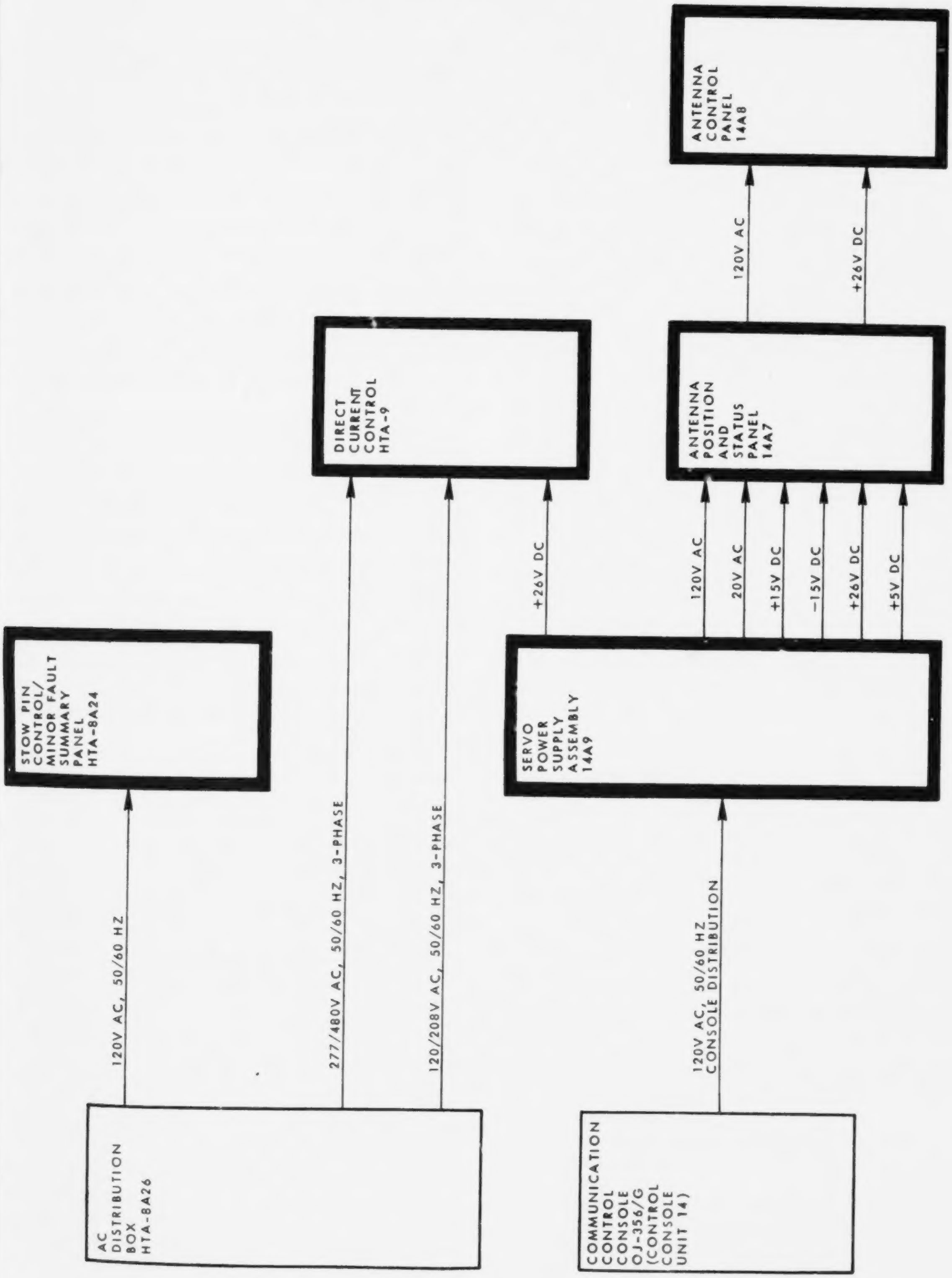

AC DISTRIBUTION BOX HTA-8A26
120V AC, 50/60 HZ
277/480V AC, 50/60 HZ, 3-PHASE
120/208V AC, 50/60 HZ, 3-PHASE
STOW PIN CONTROL/ MINOR FAULT SUMMARY PANEL HTA-8A24
DIRECT CURRENT CONTROL HTA-9
+26V DC
COMMUNICATION CONTROL CONSOLE OJ-356/G (CONTROL CONSOLE UNIT 14)
120V AC, 50/60 HZ CONSOLE DISTRIBUTION
SERVO POWER SUPPLY ASSEMBLY 14A9
120V AC
20V AC
+15V DC
−15V DC
+26V DC
+5V DC
ANTENNA POSITION AND STATUS PANEL 14A7
120V AC
+26V DC
ANTENNA CONTROL PANEL 14A8
EL5895-915-34-TM-84

Figure 2-4. Power distribution diagram.

ual relay/clutch enable signal engages the handcrank clutch and energizes the manual/follow-up relay. With the handcrank clutch engaged, operation of the handcrank mechanically positions the antenna position indicator and displaces the 1-speed (1X) and 36-speed (36X) synchros from the null position established by antenna position data feedback from the synchro control transmitters in the azimuth and elevation data modules. This action develops a manual error signal which is applied through the manual/follow-up relay to the servo analog circuit card assembly in the antenna position and status panel.

(b) ***Slew operation.*** Operation of the SLEW control in the manual mode provides a slew command to the handcrank slew control logic circuit card assembly which enables the slew relay in antenna position and status panel 14A7. The SLEW control then provides a manual slew control signal through the slew relay to the servo analog circuit card assembly in the antenna position and status panel. The SLEW control output is scaled by the servo analog circuits to allow a variable antenna slew rate of 0 to 1 degree per second depending on the displacement of the SLEW control from the center position. During slew operation, the manual relay/clutch enable signal is inhibited by the mode logic circuit card assembly. As a result, the instrument servo assembly in the antenna control panel is in a follow-up mode and the antenna position indicator and instrument servo assembly synchros are slaved to antennna position data from the data module. The SLEW controls are spring loaded to return to center (null) position when released.

(3) ***Manual mode servo analog circuit operation.*** The servo analog circuit card assembly compares the manual error signal with a 20 Hz reference signal to determine the phase of the error signal and consequently the direction of antenna movement required to null-out the error. After comparison, the manual error signal is conditioned to achieve stable servo performance and provide velocity command signals to direct current control HTA-9. The output from the servo analog circuit card assembly consists of a velocity command signal for each axis. The velocity command signals are applied through antenna position and status panel 14A7 relay circuits to the direct current control.

c. Acquisition Mode. The acquisition mode is the transitional mode between the manual and the autotrack modes. All manual functions are enabled as in the manual mode. Acquisition mode is selected by pressing the ACQUISITION pushbutton indicator switch on antenna control panel 14A8 when the antenna is in the manual mode only. Entry into and out of the autotrack mode is accomplished automatically by signals from tracking receiver control and status panel 14A6 during the acquisition mode.

d. Autotrack Mode. The autotrack mode is entered automatically and only from the acquisition mode. From this mode only the standby mode may be manually selected.

(1) Initially (with mode logic in acquisition mode), no signal is received from the satellite and antenna control is effected by the handcrank and slew controls as in manual mode. As antenna pointing approaches proximity to the satellite, the tracking beacon signal amplitude equals or exceeds the tracking threshold (ref TM 11-5895-902-34), causing a signal detected signal to be applied to the mode logic. The mode logic then inhibits processing of the manual error and slew velocity signals and provides a velocity zero signal to energize the velocity zero relay. With this relay energized, the handcrank and slew circuits are inhibited and the velocity command signal drops to zero (ground) causing all antenna movement to stop. The velocity zero signal lasts for four seconds, after which time processing of the manual error and slew velocity signals are enabled if a signal acquired signal has not been received.

(2) When a signal acquired signal is received in the specified time period, the mode logic inhibits the manual relay/clutch enable signal and provides an autotrack status signal to antenna control panel 14A8, causing the AUTOTRACK indicator to light. In addition, the mode logic circuit card assembly provides an autotrack command to energize the autotrack relay. This allows application of azimuth and elevation tracking error signals from tracking receiver control and status panel 14A6 to the servo analog circuit card assembly. The servo analog circuit card assembly provides scaling and compensation for velocity command signals. Velocity command signals are sent to direct current control HTA-9 to provide automatic positioning of the antenna in response to tracking error signal levels.

e. Slave Mode. The slave mode is selected by pressing the SLAVE MODE pushbutton indicator switch on antenna control panel 14A8 when the servo equipment is in manual mode and a slave source available signal is applied from the slave equipment. Standby mode is the only mode that can be manually selected from the slave mode. In addition, mode logic automatically goes from slave mode to manual mode if the slave source available signal is interrupted. In the slave mode, the mode logic provides a slave command signal to the relay circuits. This action causes a path to be completed for the antenna pointing error signals from the remote slave source through the manual/slave relay to the servo analog circuit card assembly. The servo analog circuit card assembly converts slave error signals to velocity command signals in exactly the same way it converts manual (handcrank) error signals (refer to subpara 2-6b(3)). The velocity command signals are applied to direct current control HTA-9.

2-7. Servo Control and Drive Fault Detection and Control (fig. FO-3 and FO-4). To facilitate location of malfunctions and prevent damage to equipment, the servo and control equipment includes major and minor fault status chains composed of interlocks and alarms. In general, antenna major faults are detected and displayed by the fault and status interlock circuits in antenna position and status panel 14A7; minor faults are detected and displayed by the minor fault summary section of stow pin control/minor fault summary panel HTA-8A24. An antenna major fault signal is one that can cause injury to personnel or a major equipment outage, should the fault be allowed to persist. A minor fault is one that presents no immediate danger to operation or equipment. Maintenance pushbutton indicator switches on the antenna position and status panel (major, fig. FO-3) and stow pin control/minor fault summary panel (minor, fig. FO-4) permit selection of major or minor maintenance. When the major or minor maintenance pushbutton indicator switch is pressed to maintenance mode, a major or minor maintenance signal is sent to system status logic unit 15A5.

a. Major Faults (fig. FO-3). Any fault or condition that is detected by the relay fault chain in antenna position and status panel 14A7 fault and status interlock circuits deenergizes the fault status interlock relay. The fault status interlock relay inhibits the scr local enable signal to direct current control HTA-9, which stops all antenna movement. The deenergized fault status interlock relay also causes a fault signal to be applied to the mode logic fault line in the antenna position and status panel, which causes an antenna major fault signal to be sent to system status logic unit 15A5 for generation of visual and audible major alarms. (For information pertaining to system status logic unit 15A5, refer to TM 11-5899-907-34.) Each detected fault or condition is displayed singly or summarily by colored lights on the antenna position and status panel. The major faults and conditions are listed below, with a discussion of each.

(1) ***Power failure.*** The +15 V dc, -15 V dc, +5 V dc, and 26 V dc outputs from servo power supply assembly 14A9 are monitored by four relays in the fault and status interlock circuits. The 20 V ac output is rectified prior to application to the relay. The POWER FAILURE indicator is lighted red when any one of the relays is deenergized.

(2) ***Handcrank engaged.*** Each azimuth or elevation gear box contains two handcrank shafts, one active and one for stowing the handcrank. Each shaft contains a microswitch assembly to protect the handcrank operator from remote operation of the active shaft. As shown on figure FO-3, when a handcrank is installed on an active shaft, in the engaged position, the switch is opened and an azimuth or elevation handcrank engaged signal is applied through direct current control HTA-9 to deenergize the respective relay in antenna position and status panel 14A7. The HANDCRANK ENGAGED indicator is lighted amber when either of the two relays is deenergized. When the handcrank is removed from the active shaft, the HANDCRANK ENGAGED light remains on until the handcrank is installed on the stow shaft, to protect against partial removal of the handcrank. Refer to TM 11-5895-900-34 for specific details of the gear boxes.

(3) ***Motor hot.*** Thermal sensors in the two elevation and the two azimuth antenna drive assembly dc drive motors are each connected in series. When a dc drive motor begins to overheat, the sensor opens a 26 V line and an azimuth or elevation motor hot status signal is applied through direct current control HTA-9 to the respective relay in antenna position and status panel 14A7. The respective AZ MOTOR HOT or EL MOTOR HOT indicator is lighted red to isolate the fault to a specific axis.

(4) ***Servo and electrical limits.*** Limit switches in the elevation and azimuth data modules sense antenna position in each axis and in each direction of antenna movement. When the antenna is driven into any of the four preset servo limits, azimuth or elevation servo limit status signal is applied to a relay in antenna position and status panel 14A7. The relay applies an opposing voltage to the servo analog circuits, preventing further antenna drive in that axis. The relay also applies an azimuth or elevation servo limit signal to antenna control panel 14A8. The azimuth or elevation servo limit signal lights the respective antenna control panel AZ SERVO LIMIT or EL SERVO LIMIT indicator amber. If the antenna is driven a few degrees past the servo limit, a major fault electrical limit is encountered. When the antenna is driven into any of the four preset electrical limits, an azimuth or elevation electrical limit status signal is applied to the respective relay in the antenna position and status panel. The AZ ELECT LIMIT or EL ELECT LIMIT indicator is lighted red to localize the condition to the correct axis. This limit can be removed only by use of the handcranks on the applicable gear box.

(5) ***Manual brake release.*** Switches connected to brake release levers on the two elevation and the two azimuth antenna drive assembly electric disk brakes are connected in series. When a lever is pulled, the switch opens a 26 V line and an azimuth or elevation brake manual switch status deenergizing signal is applied to a relay in direct current control HTA-9. When the direct current control relay is deenergized, an azimuth or elevation brakes manually released signal is applied to the respective relay in antenna position and status panel 14A7. The BRAKES MANUALLY RELEASED indicator is lighted amber when either of the relays is deenergized.

(6) ***Scr failure.*** Logic circuits in direct current control HTA-9 monitor the +15 V dc and -15 V dc sense, field 1 and 2 voltage sense, phase reference sense, and +15 V dc gate sense inputs in each axis. If any one of the sensed signals is not present, the scr fail relay for the respective axis is deenergized. The deenergized relay applies an scr fail signal to the respective relay in antenna position and status panel 14A7. The SCR FAILURE indicator is lighted red when either of the relays is deenergized. The SCR FAILURE indicator is also lighted red when the operate switch for either axis is not in the

NORMAL position. Segments of the two switches are series connected. When either switch is moved from the NORMAL position, an azimuth and elevation scr normal deenergizing signal is applied to a relay in the antenna position and status panel but is not applied in the fault and status interlock circuits fault line. The deenergized relay provides 26 V to the SCR FAILURE indicator and a ground (fault) signal to the mode logic fault line. This relay action does not inhibit the scr local enable signal; however, an antenna major fault signal is sensed by system status logic unit 15A5.

(7) ***Stowed.*** When the antenna is stowed in either axis, a deenergized relay in the stow pin control section of stow pin control/minor fault summary panel HTA-8A24 provides a stowed signal to a relay in antenna position and status panel 14A7. The STOW indicator is lighted red when the relay is deenergized.

(8) ***Antenna safe.*** Four antenna safe switch assemblies located at various positions on the antenna structure are series-connected with breakaway electrical connector plug HTA-P201 in the tower equipment group, a contact of the reflector door switch, and the key switch on antenna position and status panel 14A7. The antenna safe interlock is opened under any of four conditions: when an antenna safe switch assembly ANT SAFE pushbutton is pressed; when the antenna has been driven beyond the physical limits of the breakaway electrical connector plug; when the reflector door is opened; or when the key switch has been turned to the safe position. The open interlock provides an antenna safe status signal that deenergizes a relay in the antenna position and status panel, causing the servo and control equipment to be disabled. The ANTENNA SAFE indicator is lighted white when the relay is deenergized.

b. Major Maintenance. The MAINT pushbutton indicator switch on antenna position and status panel 14A7, when pressed to maintenance, lights the MAINT indicator and provides an antenna major maintenance signal to system status logic unit 15A5 and also provides a fault signal to the mode logic fault line in the antenna position and status panel. The mode logic fault line energizes a relay through relay driver logic and the relay applies an antenna major fault signal to the system status logic unit.

c. Minor Faults (fig. FO-4). Any fault or condition that is detected by relays in stow pin control/minor fault summary panel HTA-8A24 is displayed by amber lights on the panel. The minor fault detection relay contacts are series connected to form summary chains that control minor drive fault status and antenna minor fault status output signals. A minor drive fault status signal is applied to a relay in antenna position and status panel 14A7, deenergizing the relay. The deenergized relay lights the MINOR DRIVE FAULT indicator on the antenna position and status panel. An antenna minor fault status signal is applied to system status logic unit 15A5. The minor faults and conditions are discussed in the following subparagraphs.

(1) ***Scr fuse failure.*** The azimuth and elevation motor overload/scr fuse fail status signal in direct current control HTA-9 detects either an overload condition from either of two dc drive motors in each axis or a fuse failure condition from any of six fuses in either of the direct current control electronic control amplifiers. If either of these conditions is sensed, relay action in the direct current control causes an azimuth or elevation scr fuse status failure deenergizing signal to be applied to the respective relay in stow pin control/minor fault summary panel HTA-8A24. The deenergized relay opens the minor drive fault/antenna minor fault interlock circuit, which lights the AZ/EL SCR FUSES indicator amber and deenergizes the minor drive fault and antenna minor fault relays providing a minor drive fault status output to antenna position and status panel 14A7 and an antenna minor fault status output to system status logic unit 15A5. The minor drive fault status signal deenergizes a relay in the antenna position and status panel, causing the MINOR DRIVE FAULT indicator to light amber.

(2) ***Lube oil pressure.*** Oil pressure sensors in each of the two azimuth and two elevation speed reducer gear assemblies sense a low oil level or oil pump failure and provide an azimuth or elevation no. 1 or no. 2 lube oil flow status failure signal through direct current control HTA-9 to the respective relay in stow pin control/minor fault summary panel HTA-8A24. The failure signal deenergizes the relay, which opens the minor drive fault/antenna minor fault interlock circuit. The deenergized interlock relay circuit lights the AZ NO 1 LUBE OIL, AZ NO 2 LUBE OIL, EL NO 1 LUBE OIL, or EL NO 2 LUBE OIL indicator amber and deenergizes the minor drive fault and antenna minor fault relays, providing a minor drive fault output to antenna position and status panel 14A7 and an antenna minor fault status output to system status logic unit 15A5. The minor drive fault status signal deenergizes a relay in the antenna position and status panel, causing the MINOR DRIVE FAULT indicator to light amber.

(3) ***Nitrogen pressure.*** A pressure sensor in low pressure control panel HTA-8A31 senses a low pressure condition and sends a nitrogen pressure status signal to a relay in stow pin control/minor fault summary panel HTA-8A24. The failure signal deenergizes the relay which opens the antenna minor fault interlock circuit. The deenergized interlock relay circuit lights the NITROGEN PRESSURE indicator amber and deenergizes the antenna minor fault relay, providing an antenna minor fault status output to systen status logic unit 15A

(4) ***Air conditioner/transmit filter temperatu***
Status signals from temperature sensing devices in feed assembly HTA-1A1 high pass transmit filter FL1 and elevated equipment room HTA-2A5 thermal relay assembly A2 are combined in distribution box HTA-8A2 A failure indication from either device applies an a

conditioning/transmit filter temperature status failure signal to a relay in stow pin control/minor fault summary panel HTA-8A24. The failure signal deenergizes the relay, which opens the antenna minor fault interlock circuit. The deenergized interlock relay circuit lights the AIR COND/XMT FLTR indicator amber and deenergizes the antenna minor fault relay, providing an antenna minor fault status output to system status logic unit 15A5.

d. Minor Maintenance. The MAINTENANCE pushbutton indicator switch on stow pin control/minor fault summary panel HTA-8A24, when pressed to maintenance, lights the MAINTENANCE indicator and provides an antenna minor maintenance signal to system status logic unit 15A5.

2-8. Servo and Control Loop Description (fig. FO-5). Manual and automatic positioning of the antenna is performed by the servo and control equipment. The following subparagraphs describe the functions of each item of equipment and the equipment/antenna positioning interrelationships.

a. Antenna Control Panel 14A8 Operation. The antenna control panel provides for servo mode selection and allows manual handcrank positioning and manual slewing of the antenna. With the STANDBY indicator lighted, manual mode may be selected by pressing the MANUAL indicator switch. This provides a manual mode command output. A manual mode status input lights the MANUAL indicator and a manual relay/clutch enable signal activates the handcrank. Handcrank operation provides manual (handcrank) error signal outputs. In the manual mode, operation of the SLEW control provides slew command and manual slew velocity signal outputs. The manual (handcrank) error or manual slew velocity signals are sent to antenna position and status panel 14A7 for processing. In the manual mode, either the slave mode or the acquisition mode may be selected by pressing the respective pushbutton indicator switch. In either case, the manual mode command is applied to the antenna position and status panel to permit slave mode or autotrack mode command signals to be routed through the antenna position and status panel. A slave mode status input lights the SLAVE MODE indicator. An acquisition/autotrack mode status sequence lights the ACQUISITION MODE indicator and within four seconds, either the AUTOTRACK MODE indicator lights and the ACQUISITION MODE indicator goes out or the MANUAL MODE indicator lights and the ACQUISITION MODE indicator remains lighted.

b. Antenna Position and Status Panel 14A7 Operation. The antenna position and status panel processes the mode commands and issues mode status signals to antenna control panel 14A8, monitors fault status signals, and controls mode status relays and selection of manual and antenna pointing error signals to position the antenna. The error signals consist of a manual (handcrank) error or manual slew velocity signal from the antenna control panel when the manual mode has been selected, an antenna pointing error signal from the remote slave equipment when the slave mode has been selected, or a tracking error signal from tracking receiver control and status panel 14A6 when operating in the autotrack mode. The selected error signals are converted to azimuth and elevation velocity command signals by antenna position and status panel 14A7 analog circuits. Status signals are monitored and if no fault conditions exist, azimuth and elevation scr operate commands, azimuth and elevation scr local enable signals, and azimuth and elevation velocity commands are sent to direct current control HTA-9. Scr operate commands and scr local enable signals are generated in all modes except standby.

c. Direct Current Control HTA-9 Operation. The direct current control rectifies 3-ph, 277/480 V ac power in response to velocity command signals from antenna position and status panel 14A7 to provide dc drive power for the dc drive motors in the two azimuth and two elevation antenna drive assemblies. The direct current control contains two identical drive power control circuits, one for each antenna axis. Each control circuit includes an electronic control amplifier and dual power inductors. One scr control circuit provides dc drive power for the two azimuth dc drive motors and the other provides dc drive power for the two elevation dc drive motors.

(1) Operation of each scr control circuit is controlled primarily by 26 V dc scr local enable and scr operate command signals. The scr local enable signal is derived from the fault status and interlock circuits in antenna position and status panel 14A7. This signal enables application of power to direct current control HTA-9 circuits and energizes the contactors. The contactors apply 277/480 V ac, 3-ph power to the comparator and compensation circuits, pulse-shaping circuits, and scr assemblies. Consequently if the scr local enable signal is inhibited due to detection of a fault, operation of the direct current control is disabled. The scr operated command from the antenna position and status panel mode logic causes the direct current control circuits to provide control signals to the antenna drive assemblies to release the electric disk brakes. This action allows the antenna to be positioned by the dc drive motors in response to velocity command signals applied to the direct current control. The velocity command signal for each axis from the antenna position and status panel is applied through comparator and compensation circuits to the pulse-shaping trigger circuits. The trigger circuits use the velocity command signals to generate trains of control pulses to trigger the scr assemblies. The control pulse repetition rate is synchronized with the power-line frequency and the resultant number and phase of control pulses per half-cycle are proportional to the magnitude of the velocity command signal.

(2) The scr assemblies trigger and rectify the 3-ph input as commanded by the control pulses. Scr assembly outputs supply drive power through the respective power inductor to its associated antenna dc drive motor to drive the antenna in the commanded direction. The 277/480 V ac input power is applied through the contactor relays to each scr assembly for 3-ph, half-wave rectification. The amount and polarity of rectification, and consequently the drive power, are dependent on the number and phase of control pulses from the trigger circuit. The drive power from the scr assemblies causes the dc drive motors to develop torque and rotate the antenna in the direction corresponding to the polarity of the velocity commands. A dc tachometer-generator is mechanically coupled to the drive shaft of each dc drive motor and provides velocity feedback signals to the comparator and compensation circuits in direct current control HTA-9 electronic control amplifiers. Insertion of the velocity feedback voltage allows the scr control circuit to reduce or increase control voltage to counteract antenna movement and to provide stabilization against varying loads. The dc drive motors also develop motor current feedback, which is applied to comparator and compensation circuits. The current feedback is summed with the velocity command and velocity feedback to provide constant torquing of the antenna drive assemblies.

d. ***Antenna Drive Assemblies HTA-12A1 through 12A4 Operation.*** The azimuth axis and the elevation axis each are provided with two antenna drive assemblies. Each assembly consists of a dc drive motor, an electric disk brake, a dc tachometer-generator, and a blower. Speed and direction of each dc drive motor are determined by the magnitude and polarity of velocity command and current and velocity feedback signals through direct current control HTA-9. The output shaft of each dc drive motor is mechanically coupled to a gear box which positions the antenna. The azimuth and elevation gear boxes provide a speed reduction of approximately 10,200 to 1 and 10,500 to 1, respectively. For detailed information pertaining to the gear boxes refer to TM 11-5895-900-34.

(1) The electric disk brake is mounted over the dc drive motor shaft and prevents antenna movement when power is removed for the brake. The electric disk brake contains self-adjusting friction disks and is spring set and electrically released. The electric disk brake is applied when the scr operate command is removed. This occurs under the following conditions: When the standby mode is selected at antenna control panel 14A8; when a fault occurs in the servo and control equipment; when an antenna limit condition occurs; when an antenna is stowed; when a handcrank on one of the gear boxes is engaged; or when the antenna safe interlock circuit is opened.

(2) A lever is provided on each electric disk brake to allow the brake to be manually released. When the brake is released with the lever, a brake manually released status signal is applied by direct current control HTA-9 to antenna position and status panel 14A7 for status display. The dc tachometer-generator is also coupled to the dc drive motor shaft and provides velocity feedback to the direct current control.

e. ***Data Modules HTA-6A6A1 and HTA-8A7A1 Operation.*** The azimuth and elevation data modules are mechanically geared to the respective antenna axis. Each data module provides antenna position synchro transmitter signals to antenna position and status panel 14A7. The antenna position and status panel displays the antenna angular position and passes positional data to antenna control panel 14A8 instrument servo assemblies and to remote slave equipment. These positional data function as feedback signals in the manual mode to null error signals initially generated by movement of azimuth and elevation handcranks. When operating in the slave or autotrack mode or by slew controls, the positional data drive azimuth and elevation decimal display indicators on the antenna control panel.

SECTION II. CIRCUIT ANALYSIS OF ANTENNA CONTROL PANEL 14A8

2-9. Assembly Circuit Analysis (fig. FO-6). This paragraph provides the theory of operation for antenna control panel 14A8, based on the assembly schematic diagram. The antenna control panel provides controls and indicators to allow the operator to select operating modes and to manually position the antenna with the SLEW or handcrank controls. Azimuth and elevation servo limit indicators alert the operator to a servo limit condition.

a. ***Mode Selection and Displays.*** The switch sections of mode select pushbutton indicators S1 through S4 operate identically. Activation of a MODE switch closes the normally open contacts, connecting the 5 V return line through connector J1 to the mode selection logic in antenna position and status panel 14A7. The 5 V return line provides a logic 0 signal to the selected mode logic gate which selects the system operating mode and causes the associated lamp driver circuit to complete a path for 28 V back through J1 to the MODE indicator. The indicator portions of the MODE pushbutton indicators are identical in that the respective lamp driver outputs of the mode selection logic activate the display. The ACQUISITION portion of the ACQUISITION/AUTOTRACK pushbutton indicator is lighted when the acquisition mode has been selected. When switchover to the autotrack mode has been accomplished, the AUTOTRACK indicator lights and the ACQUISITION indicator goes out.

b. Servo Limit Indicators. Azimuth or elevation servo limit indicator DS1 or DS2 is lighted by 26 V dc through connector J1 when a servo limit is sensed by a data module limit switch mechanically linked to an antenna axis. Limit switch excitation is supplied by the 26 V dc bus in antenna position and status panel 14A7. When a limit switch senses a servo limit condition (elevation up or down, azimuth cw or ccw), corresponding relay A4K11, A4K9, A4K10, or A4K8 in the antenna position and status panel deenergizes. The normally closed contacts of relay A4K11 or A4K9 route 26 V dc to the elevation servo limit indicator. Contacts of relay A4K10 or A4K8 route 26 V dc to the azimuth servo limit indicator.

c. Azimuth and Elevation Slew Controls. Azimuth and elevation SLEW controls R2 and R1 are front-panel mounted, dual potentiometers and switches (see fig. FO-6). The SLEW controls are operationally and electrically identical. A SLEW control consists of two center-tapped potentiometers, physically connected to rotate together and spring loaded to recenter, with the wiper contact at the centertap position when released. Potentiometer section R2B has +15 V dc and -15 V dc applied across it. Any displacement of the wiper contact away from the neutral center position will apply across section R2A a voltage proportional to the displacement. This voltage is positive for counterclockwise movement and negative for clockwise movement. Since the sections are physically connected, the output from the second wiper is also proportional to the displacement. The net effect is an azimuth or elevation slew velocity output signal that is proportional to the square of the angular displacement of R2. The output polarity is a function of direction of rotation of R2. Switch R2S1 contacts are open when the SLEW control is at center (rest) position. Any clockwise or counterclockwise movement of the SLEW control closes the switch. The switch closure generates the azimuth or elevation slew command by connecting the 5 V dc return to the mode selection logic circuits. When operating in the slew mode, the mode logic energizes antenna position and status panel 14A7 relays that connect the slew velocity signal to the antenna drive circuits and disconnect the azimuth or elevation manual (handcrank) error signals from the antenna drive circuits.

2-10. Instrument Servo Assembly 14A8A1, A8A2 Circuit Analysis (fig. FO-7). Elevation and azimuth instrument servos A1 and A2 are front-panel mounted electromechanical devices, which are operationally and electrically identical. Instrument servo A1 and A2 functional elements consist of a power group, a mode control group, a servo amplifier, a phase-balancing network, an nti-stickoff network, a crossover network, and a servo ear train. These functional elements are mechanically nd electrically connected in a closed loop arrangement.

a. Power Group. Operating power for the instruent servo is supplied by 120 V ac input through filter FL-1. The filtered 120 V ac power is applied to the servo motor field and to transformers T1 and T2. Transformer T2 supplies the stickoff voltage increment for the synchros; T1 supplies 32 V ac to power supply PS1, which provides +42 V dc to servo amplifier AR1.

b. Mode Control Group. The instrument servo has two internal operating modes, manual and follow-up. A 26 V dc manual relay/clutch enable signal from the mode selection logic in antenna position and status panel 14A7 energizes relay K1 and clutch L1, and places the instrument servo in a manual mode.

(1) ***Manual mode.*** In the manual mode, L1 solenoid action engages the handcrank to the servo gear train, which drives the decimal counter and synchro rotors. Synchro error voltages are applied through normally open contacts of K1 as an azimuth or elevation manual (handcrank) ac error output to the servo analog circuits in antenna position and status panel 14A7. The instrument servo manual mode is operative in either the servo and control equipment manual or acquisition mode. In the acquisition mode, prior to receipt of signal detected/signal acquired signals from tracking receiver control and status panel 14A6, both the ACQUISITION indicator and the MANUAL indicator are lit and the hand-crank may be used for positioning the antenna. When a signal detected signal is received, the manual relay/clutch enable signal is inhibited and the handcrank is disengaged, preventing further manual operation. However, both the MANUAL indicator and the ACQUISITION indicator remain lit. The signal detect signal is present for 4 seconds, during which time the signal acquire signal should be received to enable the autotrack mode. If the signal acquired signal is not received during the 4-second interval, both indicators remain lit and the manual relay/clutch enable signal is provided to re-enable the instrument servo manual mode. If the SLEW controls are operated during the servo and control equipment manual mode, the clutch is disengaged and the instrument servo reverts to follow-up mode.

(2) ***Follow-Up mode.*** In the follow-up mode, the deenergized clutch is spring-loaded to disengage the handcrank from the servo gear train. The follow-up mode is operative in the servo and control equipment standby and autotrack modes or during manual slew operation. Antenna position synchro error signals from data module 1X and 36X synchros are applied to instrument servo stators. These error signals are applied through a crossover network through normally closed contacts of K1 and servo amplifier AR1 to servo motor B1, which repositions the instrument servo synchro rotors to null-out the error, and repositions the position indicator decimal counter to indicate the new antenna position.

c. Servo Amplifier. Servo amplifier AR1 is a phase sensitive dc amplifier. In the follow-up mode, AR1 receives ac error voltages from the crossover network and 42 V dc from power supply PS1. The ac input is used to modulate the 42 V dc to provide a varying dc output signal (28 V max) to servo motor B1. This signal is compared with the 120 V ac phase reference voltage to determine the speed and direction of rotation of the servo motor.

d. Phase Balancing Network. Any error caused by the inductive reactance of the synchro windings is offset by 1-microfarad capacitor C1 in the synchro rotor circuit.

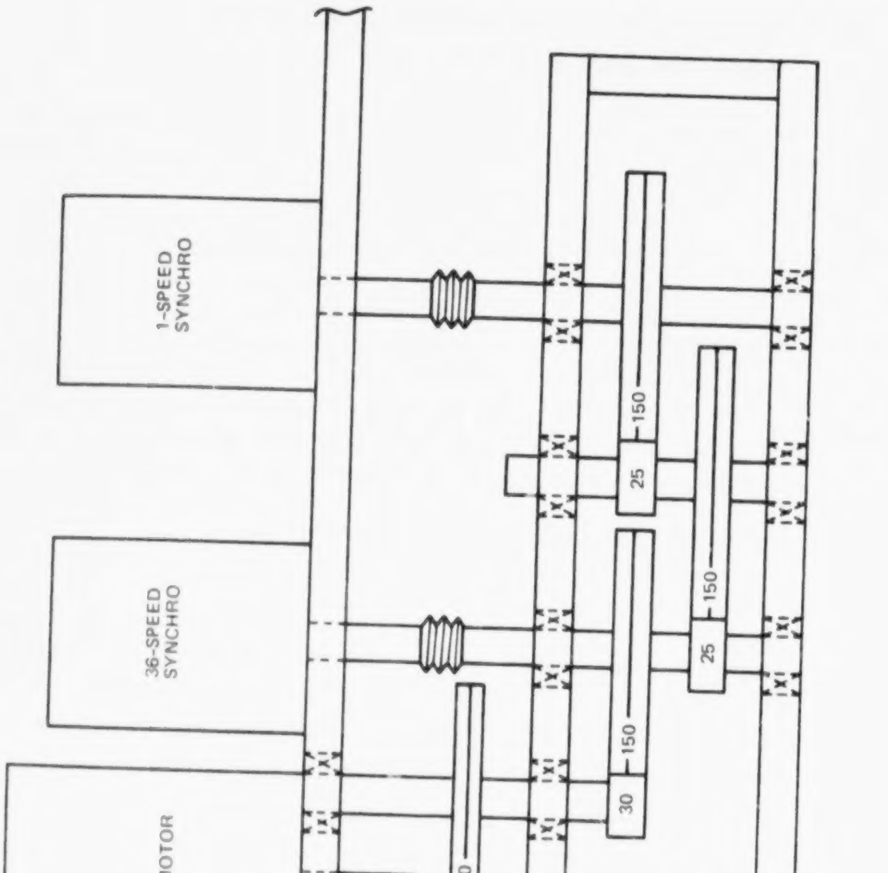
e. Anti-Stickoff Network. To prevent the coarse synchro rotor from sticking in the unaligned 180 degree position, a small voltage (2.5 V nom) is applied across the rotor terminals. This small voltage is developed across resistor R2 from the secondary winding of transformer T2.

f. Crossover Network. The purpose of the crossover network is to select the synchro stator voltage to be applied to the servo amplifier. Coarse synchro B2 controls servo positioning when error angle (stator to rotor) is greater than 2.5 degrees and fine synchro B3 is in control of angles of less than 2.5 degrees (nominal). Thus for smaller angles, error voltages developed by synchro B3 are applied through voltage divider network R3, R4, R5, and R6 to load resistor R7 or R8, depending on the operational mode. The small voltage developed by synchro B2 is blocked by diodes CR2 and CR3. For larger angles, error voltages developed by synchro B2 are applied through fired zener diodes CR4 and CR5 and voltage divider network R2, R3, and R6 to load resistor R7 or R8.

g. Servo Gear Train (fig. 2-5). The synchros, servomotor and decimal counter are mechanically linked to the handcrank by a magnetic clutch assembly in the instrument servo manual mode. The handcrank is connected to the counter through a 1-to-1 gear arrangement. In the followup mode, the clutch assembly disengages the handcrank. In either mode the servo motor is geared to the decimal counter indicator through a 4-to-1 ratio gear train; the synchros are geared together by a 36-to-1 rati gear train; the 36-speed synchro is geared to the decim counter indicator by a 1-to-10 ratio gear train.

h. Instrument Servo Manual Mode Loop. In the i strument servo manual mode (para 2-10b(1), the instr ment servo accepts a manual input from the pane mounted handcrank and antenna position signals fro the 1-speed (1X) and 36-speed (36X) synchro contr transmitters in an azimuth or elevation data module. On turn of the handcrank produces one degree of rotation the 1X synchro. The antenna position indicator displa the selected angle and the instrument servo synchro (control transformers) produce ac error voltages that a proportional to the difference between the displaye angle and the antenna position synchro signals. Larg angle differences (over 2.5 degrees) are applied throug zener diodes CR4 and CR5 (crossover network) to mod relay K1. Small angle differences are applied across voltage divider network to relay K1. Normally open co tacts of K1 pass the ac error voltages to servo anal circuits in antenna position and status panel 14A7, whe they are demodulated and used to reposition the antenn Driving the antenna to the commanded position diminis es the signal applied from the synchro control tran mitters to the instrument servo, causing the instrume servo synchro error signals to return to zero.

i. Instrument Servo Follow-Up Mode Loop. In th follow-up mode, the instrument servo accepts antenn position signals from the 1X and 36X synchro contr transmitters in a data module. The antenna position err signals are applied through the crossover network as subparagraph 2-10*h* above, through normally closed co tacts of K1 to the servo amplifier. The amplified err signals drive the instrument servo synchro rotors to n out the error and reposition the antenna position indicat to indicate the new antenna position.


1-SPEED SYNCHRO
36-SPEED SYNCHRO
SERVOMOTOR
CLUTCH
(COUNTER)
(HANDCRANK)
150
25
150
25
150
30
130
15
65
65
65
36
36
65
96
96
65

EL5895-915-34-TM-12

Figure 2-5. Instrument servo assembly 14A8A1,A8A2, servo gear train.

SECTION III. CIRCUIT ANALYSIS OF ANTENNA POSITION AND STATUS PANEL 14A7

2-11. Assembly Circuit Analysis (fig. FO-8, FO-9). This paragraph provides the theory of operation for antenna position and status panel 14A7, based on the fault status interlock circuits simplified schematic diagram (fig. FO-8) and the assembly schematic diagram (fig. FO-9). The antenna position and status panel provides status indications for selected antenna functions and conditions, antenna angular position in both azimuth and elevation axes, maintenance mode selection, and servo on/off control. Chassis-mounted transformer T1 provides isolation and reference voltages for the antenna position indicator and data module synchros. Three chassis-mounted relays and seven printed circuit cards provide the servo control logic and switching functions.

a. Fault Status Indicators. Eleven STATUS indicators on antenna position and status panel 14A7 and the AZ and EL SERVO LIMIT indicators on antenna co trol panel 14A8 are electrically activated through rel contacts in the antenna position and status panel (fi FO-8). The STATUS indicators alert operating perso nel to servo and control equipment faults. The color of th indicator light is indicative of the seriousness of the fau a red indication signifies a major fault, an amber indic tion signifies an antenna minor drive fault or operation interlock, and a white indication signifies an open safe switch. The STATUS indicators light when supplied + V dc through the deenergized control relays. Table 2- lists the indicators and other pertinent data.

Table 2-1 Status Indicator and Fault Chain Relay Data

Indicator	Color	Control relay	Alert indicator	Function indicated	Fault chain contacts
DS8	Red	A5K11	EL ELECT LIMIT	Antenna elevation electrical limit reached.	Yes
DS9	Red	A5K10	AZ ELECT LIMIT	Antenna azimuth electrical limit reached.	Yes
DS10	Red	A6K6	EL MOTOR HOT	Elevation motor hot.	Yes
DS11	Red	A6K5	AZ MOTOR HOT	Azimuth motor hot.	Yes
DS5	Red	K1	POWER FAILURE	+5 V dc power failure.	Yes
		K2	POWER FAILURE	+15 V dc power failure.	Yes
		K3	POWER FAILURE	-15 V dc power failure.	Yes
		A7K6	POWER FAILURE	20 V demodulator reference power failure.	Yes
DS4	Red	A6K7	SCR FAILURE	Direct current control azimuth circuit failure.	Yes
		A6K8	SCR FAILURE	Direct current control elevation circuit failure.	Yes
		A7K2	SCR FAILURE	Direct current control azimuth or elevation operate switch not in NORMAL position.	No
DS7	Amber	A6K9	MINOR DRIVE FAULT	Direct current control scr fuse blown or az/el gear box 1 or 2 lube oil pressure is low.	No
DS3	Red	A5K9	STOW	Azimuth or elevation stow pin is inserted in stow pin receiving hole.	Yes
DS12	Amber	A6K4	HANDCRANK ENGAGED	Elevation handcrank interlock on elevation gear box 1 or 2 is open.	Yes
		A6K3	HANDCRANK ENGAGED	Azimuth handcrank interlock on azimuth gear box 1 or 2 is open.	Yes
DS13	Amber	A6K2	BRAKES MANUAL-	Elevation brakes manually released.	Yes

Table 2-1 Status Indicator and Fault Chain Relay Data - Continued

Indicator	Color	Control relay	Alert indicator	Function indicated	Fault chain contacts
			LY RELEASED		
		A6K1	BRAKES MANUAL-LY RELEASED	Azimuth brakes manually Released.	Yes
DS6	White	A5K8	ANTENNA SAFE	Key switch is set to safe position; any of four antenna safe switches are pressed to antenna safe; reflector door is open; or breakaway electrical connector plug is open.	Yes
DS1*	Amber	A4K11	EL SERVO LIMIT	Antenna elevation servo up limit is reached.	No
		A4K9	EL SERVO LIMIT	Antenna elevation servo down limit is reached.	No
DS2*	Amber	A4K10	AZ SERVO LIMIT	Antenna azimuth servo clockwise limit is reached.	No
		A4K12	AZ SERVO LIMIT	Antenna azimuth servo counterclockwise limit is reached.	No

*Located on antenna control panel

b. ***Fault Chain.*** A second set of contacts on applicable relays, as designated in the fault chain contacts column of table 2-1 and shown on figure FO-8, provides azimuth and elevation scr local enable signals to direct current control HTA-9 when all associated relay coils are energized. Any open contact in the fault chain deenergizes relays A6K10 and A6K11 (fig. FO-8, sh 2), opening the scr local enable signal lines. A second set of contacts on relay A6K10 provides a logic low signal to the mode selection logic gates, placing the servo and control equipment in the fault mode.

c. ***Analog Antenna Position Indicators (fig. FO-9).*** The two front panel-mounted analog antenna position indicators DS1 and DS2 each consist of a calibrated dial and a 23TR6A/B torque receiver synchro attached to a pointer. These synchros are driven by antenna position (synchro-CX) signals from synchro control transmitters in the data modules through connector J1. The dials indicate the antenna position in degrees of azimuth and elevation angles. Mechanically coupled to the elevation torque receiver synchro rotor is the secant correction potentiometer (DS1R1) (fig. FO-9, sh 2). This potentiometer is electrically connected to the azimuth servo analog electronics to control the gain of that circuit as a function of elevation angle during the autotrack mode.

d. ***Maintenance Switch.*** Maintenance switch S2 (fig. FO-9, sh 4) is a pushbutton indicator switch that allows the console operator to place the servo and control equipment in a maintenance mode. When in the maintenance position, one set of switch contacts applies 26 V dc to the internal lamps providing a blue MAINT indication; a second set of contacts provides an antenna major maintenance signal via J9 to system status logic unit 15A5; the third set of contacts provides a logic low (ground) to the mode logic fault line, placing the mode logic in the non-indicated fault mode.

e. ***Antenna Safe Interlock Switch.*** Antenna safe interlock switch S1 (fig. FO-8) is a key-operated, two-position switch, connected externally in series with other safety interlock switches. When all external safety interlock switches are closed, S1 receives 26 V dc through connector J2. When set to on (clockwise), S1 provides 26 V dc to relay A5K8. One set of A5K8 contacts is in the fault chain, the other set provides 26 V dc to light ANTENNA SAFE indicator DS6 when the relay is deenergized. When S1 is set to safe (counterclockwise), relay A5K8 is deenergized, which lights DS6 and opens the fault chain, inhibiting the mode selection logic.

2-12. Mode Logic Circuit Card Assembly 14A7A1 Circuit Analysis (fig. FO-10). This assembly contains logic circuits that mechanize the mode of servo and control equipment operation. Logic levels are 0 V dc for a logic low and 5 V dc for a logic high. A logic low is active. The assembly also contains demodulator network A5, consisting of four diodes that provide a dc operating voltage for ac supply relay A7K6. Mode selection is accomplished by pressing a MODE pushbutton on antenna control panel 14A8, which enables the associated latching arrangement through multiple input control gates. The latching arrangement is implemented by two complementary M11-type NAND gates that function like flip-flops. The latch outputs, in combination with control closure inputs, enable other control gates that in turn enable relay and lamp drivers. The associated mode lamps in the antenna control panel provide a visual display of the operating mode, and relays in the antenna position and status panel implement the mode. The logic provides four operating modes: manual, slave, acquisition, and autotrack. Standby is a nonoperating mode and is used to control entry into the other modes. The fault mode is a nonindicated, nonoperating mode. When the fault mode logic is active, the logic provides inhibit levels to all other modes, including standby.

a. Fault Mode Logic. A major fault is sensed by the mode logic when a logic low is present on the mode logic fault line at pin 1 of connector P3. This occurs as a result of any of the following conditions: When maintenance switch S2 is pressed to on, when scr normal relay A7K2 deenergizes because of an open operate switch in direct current control HTA-9, or when scr control enable relay A6K10 deenergizes because of an active alarm or open interlock in the servo fault chain (see fig. FO-7). The logic low at P3-1 establishes a mode logic fault line that applies the low to NAND gates M5U17 (pin 1), M1U16 (pin 1), M1U15 (pin 12), M4U2 (pin 1), M1U16 (pin 5), M4U1 (pin 1), M5U18 (pin 5), M5U17 (pin 9), M6U19 (pin 5), and to inverter M2U8 (pin 1), inhibiting all modes.

(1) ***Standby mode inhibit.*** The high output of M1U15 is applied to pin 3 of inverter M2U8 to provide a low to the base (pin 6) of core driver M9U4. The core driver output provides a high signal to P4-3 to turn off the STANDBY indicator. The logic low to M5UM (pin 1) is twice inverted to provide a standby mode set signal to NAND latch M11U22 (pin 1). M1U16 (pin 3) output provides a reset signal to NAND latch M11U22 (pin 5). The high output of M11U22 (pin 3) is also applied to M11U22 (pin 4) input. The low output of pin 4 clamps the high signal at pin 3 output, which is applied to pin 5 of inverter M2U8 to provide a low to the base of core driver M9U4 (pin 9). Pin 9 provides a high signal to P4-5, which deenergizes the scr operate command relay.

(2) ***Operational mode inhibit.*** Logic lows to manual mode NAND gates M4U2 (pin 1) and M1U16 (pin 5) provide reset signals to NAND latch M11U22 (pins 9 and 10) and the low output of the latch inhibits the manual mode. Lows to M4U1 (pin 1) and M5U18 (pin 5) similarly inhibit the acquisition mode, and lows to M5U17 (pin 9) and M6U19 (pin 5) inhibit the slave mode.

(3) ***Fault status signal generation.*** A low signal to pin 1 of inverter M2U8 is again inverted by M2U12 (pin 13) to provide a low to pin 2 of core driver M9U4. The resultant high at the collector of M9U4 (pin 1) is applied to P4-1, deenergizing the major fault status relay and providing an antenna major fault status signal to an external monitor.

(4) ***Standby drive threshold inhibit generation.*** A major fault logic low is applied to NAND gate M4U1 (pin 9) and the high output turns on core driver M9U6 (pin 6) to provide a standby drive threshold inhibit signal at P4-7; however, no external connection is provided for this signal.

(5) ***End of fault mode logic status.*** When a fault is corrected, the fault line goes high and standby mode is selected electronically. The manual, acquisition, and slave mode NAND latches are not affected because existing lows at pins 13 of M4U2, M4U1, and M5U17 present highs to the three latches. The resultant highs at pins 1, 2, and 13 of M4U3 inputs cause a low input to M5U17 (pin 5), which maintains the standby latch high output status. Highs at pins 13 and 12 of M1U15 turn on the STANDBY indicator. A high to M2U8 (pin 1) causes P4-1 to go low, removing the fault status signal at the external monitor.

b. Standby Mode Logic. The standby mode is selected electronically at the end of a fault as described above or after a power down condition by turn-on delay group A1, A2, and inverters M2U8. The standby mode may be selected manually when the servo system has been operating in any one of the operational modes.

(1) ***Turn-on delay standby mode selection.*** When the +5 V dc is turned on at servo power supply assembly 14A8, P1-1 and P1-2 distribute +5 V dc to all logic components and to turn-on delay network A2. Capacitor A1C1 provides a voltage divider across resistors A2R and A2R4. The voltage divider provides a 0.5 ms (approximate) duration, low resistance patch (500 ohms) for the 5 V dc, which provides a logic low to inverter M2U8 (pin 9) and thus to NAND gate M5U17 (pin 2). The low at pin 2 causes a low input to NAND latch M11U22 (pin 1), forcing the standby mode and preventing random selection of an operational mode. When the capacitor is charged, the signal at pin 2 goes high. When +5 V dc power is lost due to a malfunction or turnoff, the capacitor first senses the change and the resultant low at pin causes the logic to revert to the standby mode.

(2) ***Manual standby mode selection.*** The standby mode is manually selected by pressing STANDBY switch S2 on antenna control panel 14A8. This provides a momentary low at P3-3 and pin 4 of NAND gate M5U17. This establishes a standby condition that is the same as the fault mode condition detailed in paragraph 2-12a except that M1U15 (pins 13 and 12) are both high, which turns on the STANDBY indicator. The standby mode NAND latch outputs provide a set signal to the manual mode logic and reset signals to the acquisition and slave mode logic so that entry to the manual mode is the only possible operating transition.

c. ***Manual Mode Logic.*** The manual mode is selected by momentarily pressing MANUAL MODE switch S3 on antenna control panel 14A8. From the standby mode, S3 inputs a logic low to pins 2 and 3 of NAND gate M1U15, which sets manual latch M11U22 (pin 9) and resets the standby, slave, and acquisition latches. The manual latch set condition and the slave and acquisition latches reset conditions enable NAND gate M4U3 (pins 3, 4, and 5) to light the MANUAL indicator by means of lamp driver M9U4 (pin 13). The manual latch set condition also provides the manual enable to relays A2K1 and A1K1, instrument servo clutches, and slew relays A5K1 and A5K2. The manual relays and clutches are energized to enable handcrank control of the antenna. In the manual mode, operating a SLEW control on the antenna control panel from its center (off) position closes slew switch R1S1 or R2S1 on the antenna control panel. The closed slew switch provides a logic low through pin P3-17 or P3-19 to manual relay core driver M9U7 (pin 2 or 6), preventing handcrank operation. The slew signal is also inverted and gated to enable slew relay core driver M9U7 (pin 9 or 13), which energizes slew relay A5K2 or A5K1. The manual latch is reset only when the standby latch is set, except in the case of a fault; therefore, the manual latch remains set in the slave and acquisition modes. The acquisition, slave, or standby mode may be selected from the manual mode. If the MANUAL mode is selected when operating in the acquisition or slave mode, the respective latch is reset, the corresponding MODE indicator goes off, and the MANUAL MODE indicator lights. Also, when a loss of the signal acquired signal occurs in the autotrack mode, the mode logic reverts to the manual and acquisition modes, lighting both MANUAL and ACQUISITION indicators on the antenna control panel.

d. ***Acquisition/Autotrack Mode Logic.*** The acquisition mode is entered manually by momentarily pressing ACQUISITION pushbutton indicator switch S1, provided that the servo and control equipment is currently operating in the manual or slave mode. The acquisition mode is entered automatically from the autotrack mode when the signal acquired signal is lost. Both acquisition and manual modes exist at this time. Pressing the ACQUISITION pushbutton indicator switch provides a logic low at P3-7 to set acquisition latch M11U23 (pin 1) and reset M11U23 (pin 5). The set acquisition latch resets the slave latch if acquisition mode entry is from slave mode. The manual latch remains set. The autotrack mode s entered automatically after a successful signal detect/signal acquire sequence. The signal detect and signal acquire signals originate in tracking receiver control and tatus panel 14A6. These signals control their respective elays A5K5 and A5K4 in antenna position and status panel 14A7. These relays, when energized, provide logic levels to the autotrack mode logic to condition the logic o three possible operating states discussed below.

(1) ***No signal detect, no signal acquire state.*** Both signal relays being deenergized provide logic highs to inverters M2U13 (pins 9 and 11) and to pin 11 of NAND gate M4U3. The signal acquired high is inverted to inhibit gate M4U3 (pin 10). The high output (pin 8) provides an enable to gates M1U16 (pin 10) and M5U18 (pin 12). Outputs of these gates turn on core drivers that turn on MANUAL indicator switch S3 and the upper legend ACQUISITION of ACQUISITION/AUTOTRACK indicator switch S1. The signal detect high is inverted by M2U13 (pin 11) to inhibit gate M1U16 (pin 13) and to provide a high to enable gate M5U18 (pin 13), which provides an enable to manual relays and clutches and to the slew logic. Thus, full manual mode control is maintained, allowing handcrank and slew control of the antenna in the acquisition mode.

(2) ***Signal detect.*** The next step of the acquisition process is detection of the satellite signal and energizing of the signal detect relay. MANUAL MODE indicator switch S3 and ACQUISITION MODE indicator switch S1 (upper segment) remain lit, since no change occurs in their logic. The signal detect low input, inverted by M2U13 (pin 11), and the acquisition latch high output enable gate M1U16 (pins 12 and 13) to provide the velocity zero signal at P4-28, which energizes relay A7K5. The velocity zero relay contacts short to ground the velocity command outputs. The low output of M1U16 (pin 11) inhibits M5U18 (pin 13), which inhibits the manual and slew control gates, preventing any manual control of the antenna.

(3) ***Signal acquire.*** The next step of the acquisition process is the phaselock condition of tracking receiver control and status panel 14A6, in which signal acquire relay A5K4 is operated (energized). After a 4 second delay, signal detect relay A5K4 is restored (deenergized). (For details of signal detected/signal acquired sequence, refer to TM 11-5895-902-34.) The deenergized signal detect relay allows the velocity zero relay to deenergize and restore the velocity command outputs to direct current control HTA-9 and enable antenna drive. The three inputs to M4U3 (pins 9, 10, and 11) are now high to perform the following functions:

(a) Relay drivers M9U5 (pin 13) and M9U6 (pin 2) are enabled, providing voltages to illuminate the AUTOTRACK segment of ACQUISITION/AUTOTRACK indicator switch S1 and to energize elevation autotrack relay A4K7, azimuth autotrack relay A4K5, and azimuth autotrack status relay A7K4. The energized autotrack relays connect azimuth and elevation tracking error signals from tracking receiver control and status panel 14A6 to the analog circuits. These signals are then used to automatically track the satellite.

(b) Manual and slew gates are disabled by a logic low on NAND gate M5U18 (pin 12).

(c) MANUAL indicator switch S3 is disabled by a low on NAND gate M4U3 (pin 5).

(d) The ACQUISITION segment of ACQUISITION/AUTOTRACK indicator switch S1 is disabled by a low on NAND gate M1U16 (pin 10).

e. ***Slave Mode Logic.*** The SLAVE mode is selected by momentarily pressing SLAVE indicator switch S2, provided that the equipment is currently operating in the manual mode, or MANUAL mode has been selected, and slave available relay A5K3 is energized. Direct entry into the slave mode is not possible from standby or acquisition modes, due to logic low signals presented to M6U19 (pins 1 and 4) by standby and acquisition latches. The slave available relay, when deenergized, also presents a logic low to M6U19 (pin 3). Pressing the SLAVE indicator switch provides a logic low to set slave latch M11U23 (pin 9). The set condition of the latch enables lamp and relay core drivers M9U5 (pins 6 and 9), which energize slave relays A4K1, A4K2, and A7K3 and light SLAVE MODE indicator switch S2. The manual latch remains set, MANUAL indicator switch S3 goes out, and the manual relays are inhibited. Acquisition, manual, or standby mode may be selected from the slave mode. The manual mode remains latched and therefore manual mode selection merely turns off the SLAVE MODE indicator. The slave latch is reset when the new mode is entered.

2-13. Servo Analog Circuit Card Assemblies 14A7A2 and 14A7A3 Circuit Analysis (fig. FO-11).

Azimuth and elevation servo analog circuit card assemblies contain electrically identical circuits. The analog circuits provide operational amplifiers and electrical components necessary to implement servo analog functions. Servo analog functions are gain scaling and signal compensation for error inputs and servo limit control. The primary function of the analog circuits is to scale and limit the various mode error inputs to provide a velocity command scaler output to antenna drive circuits in direct current control HTA-9. A secondary function is to provide a grounding path for the velocity command output when a servo limit is sensed. The source of velocity input determines the internal operating mode by setting appropriate relays. The internal modes are manual handcrank/slave, autotrack, manual slew, and servo limit control.

a. ***Manual Handcrank/Slave Operation.*** Deenergized relay K1 on relay circuit card assembly A4 (para 2-14) selects the single composite ac synchro (manual, handcrank) error signal from the instrument servo crossover network in the system manual mode. Energized relay K1 selects the composite ac synchro (slave) error signal from the slave source in the slave mode. Both of these synchro error signals enter the analog circuit card at P1-15 and P1-16.

(1) A manual (handcrank) or slave error voltage of 3.1 V rms/degree is applied to unity-gain, inverting operational amplifier network U2, A3, and A5C2. The output of U2 is applied to demodulation network A9 and A10. The 20 V rms synchro reference from the servo power supply is applied through P1-25 and P1-26 to th inverting output of operational amplifier network U1 an A2, which is connected as a zero cross detector (no fee back). The output of U1, a 60 Hz square wave wit peak-to-peak amplitude of +15 V dc, is applied direct to demodulator network A10 and is inverted by unity ga operational amplifier network U4 and A7 and the applied to demodulator network A9. The two phases o synchro reference, 180 degrees apart, alternately dri demodulator switch transistors A11Q1 and A11Q2 o and off to control the phase of the error signal applied operational amplifier network U5, A12, and A13. Th operational amplifier is connected as an integrating di ferential amplifier. Since the demodulator switch trans tors are alternately on and off at a reference 60 Hz rat the error is alternately applied to the inverting and no inverting input of U5 at this rate. Thus, when the err signal and the reference signal are in phase, the output U5 is a positive voltage representing counterclockwi antenna drive. A negative voltage occurs at 180 degre out of phase and any out-of-phase relationship betwe the two signals causes a corresponding dc output voltag The gain of U5 is controlled by the feedback loop throug gain scaling network A8 to A12R1 and A13C2 and inverting input of U5. HT/MT scale change relay A4K remains deenergized in either the AN/FSC-78(V) AN/FSC-79 terminal configuration and therefore th open contacts preclude any effect on the circuit.

(2) The output of U5 is applied through co tacts of deenergized autotrack relay A4K5 and contac of deenergized slew relay A5K1 to the input of invertin operational amplifier network U6, A14, A15, and A1 connected as a unity gain, integrating amplifier. The ou put of U6 cannot go more positive than +10 V dc or mo negative than -10 V dc because of 10 V limit netwo A19, which is connected from output to input of U6. T output of U6 is applied through contacts of velocity ze relay A7K5 to direct current control HTA-9 as a positi or negative dc voltage velocity command.

b. ***Autotrack Operation.*** When the antenna is ope ating in the autotrack mode, a bipolar dc voltage trackin error from tracking receiver control and status pa 14A6 is applied through connector P1 (pins 5 and 6) the inverting input of integrating operational amplifi network U3, A1, A4, and A6. Operational amplifier U gain is controlled by gain scaling network A8. A trackin error input of 7.0 V/degree provides a U3 output of V/degree, through contacts of energized autotrack re A4K5 and deenergized slew relay A5K1 to U6. The si nal is then processed as in the manual/slave operati described above. The output of U6 is applied to dir current control HTA-9 as a velocity command signal steer the antenna automatically by means of trackin error signals. An additional control over the gain of is contained in the azimuth circuit only, during autotra operation. The energized contacts of autotrack re A4K5 connect secant correction potentiometer into feedback patch of U6. The secant correction potentiometer operates as an elevation angle cosine potentiometer. The potentiometer is mechanically coupled to ELEVATION position indicator DS1 synchro in antenna position and status panel 14A7. When the antenna is at zero degrees elevation (scanning the horizon) the elevation position indicator indicates zero degrees and places the wiper of the potentiometer furthest from ground to connect the output of U6 directly to the feedback path of U6 to provide unity circuit gain. As the antenna increases in elevation, the potentiometer wiper moves toward ground and applies a voltage proportional to the cosine of the elevation angle as feedback for U6. This decrease in feedback, as the elevation angle increases, increases the closed loop gain of U6 proportionally to the secant of the elevation angle, allowing the azimuth axis to drive faster at higher elevation angles, compensating for higher satellite angular rates near the zenith.

*c. **Manual Slew Operation.*** With the servo equipment operating in the manual mode, the handcrank input normally controls the antenna. Operating the AZ SLEW or EL SLEW control energizes the azimuth or elevation slew relay in antenna position and status panel 14A7 and deenergizes the manual relay in the respective instrument servo. The deenergized manual relay places the instrument servo in the follow-up mode. The energized slew relay connects the slew potentiometer slew velocity signal to U6 input. The slew velocity signal is conditioned as in the manual (handcrank)/slave operation and the output to direct current control HTA-9 is a slew velocity signal with a gain of 0.667.

*d. **Servo Limit Control.*** The output of U6 is controlled by servo limit networks A16 and A17 and A4K10/A4K8 servo limit relay contacts, should a servo limit be exceeded by the antenna. The circuit has no effect on operation with the relays deenergized. For example, should the antenna be driven into the azimuth servo limit and open the clockwise servo limit switch, clockwise servo limit relay A4K10 will deenergize. The servo limit relay contacts then remove +15 V dc and apply -15 V dc to servo limit network A16. This action causes the antenna to stop driving in the clockwise direction and to start driving slowly in the counterclockwise direction, the effect of which is to electrically back-off the antenna from the limit condition. Counterclockwise servo limit network A17 operates in a similar manner to limit the output of U6 to the same positive voltage.

2-14. Relay Circuit Card Assemblies A4 through A7 Circuit Analysis (fig. FO-12). Assemblies A4, A5, A6, and A7 (fig. FO-12, sh 1, 2, 3, and 4, respectively) are four identical relay circuit cards, each containing 11 relays with double-pole, double-throw contact sets. These circuit cards provide all relay functions for antenna position and status panel 14A7 and antenna control panel 14A8, with the exception of manual/follow-up relays in the control panel assembly instrument servos and chassis-mounted power supply fail relays in the antenna position and status panel. The terminations shown in figure FO-12 are keyed to block connections shown in figure FO-9.

SECTION IV. CIRCUIT ANALYSIS OF SERVO POWER SUPPLY ASSEMBLY 14A9

2-15. Assembly Circuit Analysis (fig. FO-13). This paragraph provides the theory of operation for servo power supply assembly 14A9 based on the assembly schematic diagram. The servo power supply assembly provides dc output voltages of +5 V dc, +15 V dc, -15 V dc, and +26 V dc and ac output voltages of 20 V ac and 120 V ac. To provide these output voltages the servo power supply assembly contains four modular power supplies (PS1 through PS4) and step-down power transformer T1. In addition, the assembly includes front panel meter M1 and switch S1 to monitor the power supply output voltages. A functional description of the servo power supply assembly is contained in the following paragraphs.

a. Single-phase, 120 V ac power is applied through onnector J1 pin A and terminal board TB1 of the servo ower supply assembly to SYNCHRO REFERENCE 20 V ac circuit breaker CB1 and primary power circuit reakers CB2 through CB5. Circuit breaker CB1 pro-ides circuit protection against overload conditions and pplies 120 V ac to pin J of connector J2 and to the primary of transformer T1. The 120 V ac applied to pin J of connector J2 is distributed to position-indicator synchros on antenna position and status panel 14A7 for use as a reference voltage. The 120 V ac applied to transformer T1 is stepped down to 20 V ac and applied to pins S and T of connector J2 for distribution to servo analog circuit card assemblies contained in the antenna position and status panel.

b. Prime power circuit breakers CB2 through CB5 provide circuit protection and control application of power to power supplies PS1 through PS4. The 26 V dc power supply PS1 is adjustable and provides a regulated 26 V dc output with a maximum full load current capability of 25 A. The 26 V dc power supply is a sealed, nonrepairable unit. The 26 V dc output from power supply PS1 is applied to circuit breakers CB6 and CB7. Circuit breaker CB6 applies 26 V dc to pin D of connector J2 for distribution to external lamp testing circuits. Circuit breaker CB7 applies 26 V dc to pins A, B, and C of connector J2. The 26 V dc from pin A is distributed to antenna position and status panel 14A7 and from pins B and C to direct current control HTA-9.

c. Positive and negative 15 V dc power supplies PS2 and PS3 are identical except for output polarity. The output for the +15 V dc power supply is derived from the positive output side at pin 6 of terminal board TB1 and for the -15 V dc power supply from the negative output side at pin 4. The positive and negative 15 V dc power supplies are adjustable and provide a maximum full load current capability of 2.2 A. The positive and negative 15 V dc power supply outputs are applied through connector J2 to antenna position and status panel 14A7.

d. The 5 V dc power supply PS4 is adjustable and provides a regulated 5 V dc output with a maximum full load capability of 5 A. The 5 V dc power supply output is distributed to antenna position and status panel 14A7.

e. An overvoltage protector (Z1 through Z3) is connected across each 5 V dc and 15 V dc power supply. These units protect the respective power supply load circuit from an overvoltage condition in the event of faulty power supply regulation. Overvoltage protector Z1 is preadjusted to limit +15 V dc power supply PS2 output to +16.5 V dc and Z2 is preadjusted to limit -15 V dc power supply PS3 output to -16.5 V dc. Overvoltage protector Z3 is preadjusted to limit 5 V dc power supply PS4 output to 6.5 V dc. Provision is made on the front of the servo power supply assembly to monitor all power supply outputs by means of VOLTAGE MONITOR switch S1 and meter M1. Operating the switch to a selected output connects the respective power supply output through an appropriate meter multiplier resistor to the meter. Proper power supply output is indicated when the meter pointer is in the green area of the meter scale.

2-16. 15 V DC Power Supply 14A9PS2,PS3 Circuit Analysis (fig. FO-14). The +15 V dc and -15 V dc power supplies provide regulated 15 V output at 2.2 A and contain protective circuits for overcurrent conditions. Each 15 V dc power supply consists of an ac input circuit, a main rectifier, a bias supply and a series voltage regulator circuit.

a. Ac Input Circuit. Single-phase 120 V ac input power is applied to transformer T1. Transformer T1, which contains two secondary windings, steps down the input voltage for application to the main and auxiliary rectifiers.

b. Bias Supply. The bias supply, consisting of half-wave auxiliary rectifier CR7, filter capacitor C7, and zener diode regulator CR6, provides operating voltage for error amplifiers Q1 and Q2 and current limit amplifier Q3. Zener diode CR1 and resistor R5, which are connected across the bias supply, provide a regulated temperature compensated reference voltage. Resistor R4 compensates for input voltage variations.

c. Main Rectifier. The main rectifier consists of bridge rectifiers CR8 through CR11 and filter capacitor C8. Bridge rectifiers CR8 through CR11 perform wave rectification of ac voltage from transformer T provide a dc voltage that is filtered by capacitor C8. filtered dc voltage is applied to series regulator Q8.

d. Series Voltage Regulator Circuit. The series v age regulator circuit regulates dc output voltage and p vides overcurrent protection. The series voltage regula circuit is composed of error amplifiers Q1 and Q2, c rent limit amplifier Q3, driver Q5, and series regula Q8. Series regulator Q8 receives dc voltage from the ma rectifier and controls the output by presenting a varia impedance in series with the load. The regulated 15 V output is taken across pins 6 and 4 of terminal board TB The dc output voltage is adjustable from 14.25 V dc 15.75 V dc by potentiometer R1. Series regulator (which regulates the dc output voltage to the adjusta value established by potentiometer R1, is controlled signals derived from error amplifiers Q1 and Q2 or c rent limit amplifiers Q3. Error amplifiers Q1 and (provide the control signal under normal load conditio and current limit amplifier Q3 provides the control sig during overload conditions.

(1) ***Normal load regulation.*** Operation of series regulator circuit is determined by changes in output voltage. A change in the output voltage is sens by sensing divider resistors R2 and R3 and potentiome R1, which compare the output voltage with the + sen (+S) reference voltage. The +S reference voltage is tablished by zener diode CR1 and resistor R5. Compa son of the output voltage with the +S reference volta produces an error voltage at the junction of resistors and R3, which is amplified by error amplifiers Q1 and (and is current amplified by driver Q5. The correspond change in driver Q5 emitter current drives the emit base junction of series regulator Q8. This action increa the emitter-to-collector voltage drop of series regula Q8 to decrease the output voltage if the output volta has increased, and decreases the emitter-to-collector d to increase the output voltage if the output voltage decreased.

(2) ***Overcurrent operation.*** If a large increas load current occurs, current limit amplifier Q3 takes o regulation control at a specific point and effectively c rent-regulates the output. Operation of current limit a plifier Q3 is controlled by a preset voltage refere applied to the base junction and a voltage applied to emitter junction, which is proportional to output l current. The preset voltage reference is developed by voltage divider composed of potentiometer R17 and sistor R18. The current limit value is determined by factory setting of potentiometer R17. The output current is sampled by resistor R14, which is in series the output current path. Under normal load conditio current limit amplifier Q3 is held cutoff by the pre reference voltage. A large increase in load current p duces increased forward bias for Q3 developed by res

R14 and at a specific point overcomes the preset voltage reference, at which time Q3 conducts. Conduction of current limit amplifier Q3 results in decreased conduction of driver Q5. Decreased conduction of driver Q5 causes a less positive potential to be developed across resistor R22 and consequently causes a reduction in the forward bias of series regulator Q8. As a result, the emitter-collector impedance of Q8 is increased, reducing the output voltage lower than the initial drop due to the overload, effectively limiting the output current to a safe value. When operating conditions approach short circuit, the output voltage decreases. Since the voltage determined by potentiometer R17 and resistor R18 is proportional to the output voltage, current limit amplifier Q3 is successively biased into turnon at lower and lower load currents as the output voltage decreases. This action permits the current limit amplifier to turn on at lower and lower load currents until output voltage decreases to zero and current decreases to a predetermined low value.

2-17. +5 V DC Power Supply 14A9PS4 Circuit Analysis (fig. FO-15). The +5 V dc power supply provides a regulated +5 V dc output at 5.1 A and contains protective circuits for overcurrent conditions. The +5 V dc power supply consists of an ac input circuit, a main rectifier, a bias supply, and a series voltage regulator circuit.

a. Ac Input Circuit. Single phase 120 V ac input power is applied to transformer T1. Transformer T1, which contains two secondary windings, steps down the input voltage for application to the main and auxiliary rectifiers.

b. Bias Supply. The bias supply, consisting of half-wave auxiliary rectifier CR7, filter capacitor C7, and zener diode regulator CR6, provides operating voltage for error amplifiers Q1 and Q2 and current limit amplifier Q3. Zener diode CR1 and resistor R5, which are connected across the bias supply, provide a regulated temperature compensated reference voltage. Resistor R4 compensates for input voltage variations.

c. Main Rectifier. The main rectifier consists of rectifiers CR9 and CR11 and filter capacitor C8. The rectifiers perform full wave rectification of the ac voltage from transformer T1 to provide a dc voltage that is filtered by capacitor C8. The filtered dc voltage is applied to series regulator Q8.

d. Series Voltage Regulator Circuit. The series voltage regulator circuit regulates the dc output voltage and provides overcurrent protection. The series voltage regulator circuit is composed of error amplifiers Q1 and Q2, current limit amplifier Q3, driver Q5, and series regulator Q8. Series regulator Q8 receives dc voltage from the main ectifier and controls the output by presenting a variable mpedance in series with the load. The regulated 5 V dc utput is taken across pins 6 and 4 of terminal board TB1. he dc output voltage is adjustable from 4.75 V dc to 5.25 dc by potentiometer R1. Series regulator Q8, which regulates the dc output voltage to the adjustable value established by potentiometer R1, is controlled by signals derived from error amplifiers Q1 and Q2 or current limit amplifiers Q3. Error amplifiers Q1 and Q2 provide the control signal under normal load conditions and current limit amplifier Q3 provides the control signal during overload conditions.

(1) *Normal load regulation.* Operation of the series regulator circuit is determined by changes in the output voltage. A change in output voltage is sensed by sensing divider resistors R2 and R3 and potentiometer R1, which compare output voltage with the + sense (+S) reference voltage. The +S reference voltage is established by zener diode CR1 and resistor R5. Comparison of the output voltage with the +S reference voltage produces an error voltage at the junction of resistors R2 and R3, which is amplified by error amplifiers Q1 and Q2 and current amplified by driver Q5. The corresponding change in driver Q5 emitter current drives the emitter-base junctions of series regulator Q8. This action increases the emitter-to-collector voltage drop of series regulator Q8 to decrease the output voltage if the output voltage has increased, and decreases the emitter-to-collector drop to increase the output voltage if the output voltage has decreased.

(2) *Overcurrent operation.* In the event of a large increase in load current, current limit amplifier Q3 takes over regulation control at a specific point and effectively current-regulates the output. Operation of current limit amplifier Q3 is controlled by a preset voltage reference applied to the base junction and a voltage applied to the emitter junction, which is proportional to output load current. The preset voltage reference is developed by the voltage divider composed of potentiometer R17 and resistor R18. The current limit value is determined by the factory setting of potentiometer R17. The output load current is sampled by resistor R28, which is in series with the output current path. Under normal load conditions, current limit amplifier Q3 is held cut-off by the preset reference voltage. A large increase in load current produces increased forward bias for Q3 developed by resistor R28 and at a specific point overcomes the preset voltage reference, at which time Q3 conducts. Conduction of current limit amplifier Q3 results in decreased conduction of driver Q5. Decreased conduction of drivers Q5 and Q6 causes a less positive potential to be developed across resistor R22 and consequently causes a reduction in the forward bias of series regulator Q8. As a result, the emitter-collector impedance of Q8 is increased, reducing the output voltage lower than the initial drop due to the overload, effectively limiting the output current to a safe value. When operating conditions approach short circuit, the output voltage decreases. Since the voltage determined by potentiometer R17 and resistor R18 is proportional to the output voltage, current limit amplifier Q3 is successively biased to turn-on at lower and lower load currents as the output voltage decreases. This action per-

mits the current limit amplifier to turn on at lower and lower load currents until output voltage decreases to zero and current decreases to a predetermined low value.

SECTION V. CIRCUIT ANALYSIS OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24

2-18. Assembly Circuit Analysis (fig. FO-16). Stow pin control/minor fault summary panel HTA-8A24 provides local control and monitoring of certain antenna functions. Dc operating power is supplied by +26 V dc power supply PS1. The power supply is sealed and is nonrepairable. The unit contains a voltage adjust locking potentiometer. Once set, no further adjustment should be required. The power supply receives 120 V, 60 Hz through J1 and circuit breaker CB1. The other functions are discussed below.

2-19. Rain Deflector Switch HTA-8A24S5 (fig. FO-16, sh 1). The rain deflector circuit is operated from alternate action pushbutton indicator switch S5. Pressing RAIN DEF ON switch S5 provides a 26 V dc rain deflector on command through J3 pin N to an external relay. When the external rain deflector relay closes, the RAIN DEF ON indicator lights white.

2-20. Maintenance Switch HTA-8A24S6 (fig. FO-16, sh 1). Maintenance switch S6 is an alternate action pushbutton indicator switch. Pressing the switch to the on position applies 26 V dc to light the MAINTENANCE indicator blue and to provide an antenna minor maintenance signal through J4 to system status logic unit 15A5.

2-21. Minor Drive Fault Circuit (fig. FO-16, sh 2). The minor drive fault circuit contains relays and indicators to provide a front panel display of low oil pressure for any speed reducer gear assembly or a fuse failure in direct current control HTA-9. The six normally closed relay inputs apply 26 V dc excitation voltage to energize stow pin control/minor fault summary panel relays. The energized relays then remove 26 V dc from the indicators to extinguish them. When a fault occurs, the relay opens, deenergizing the panel relay and lighting the indicator amber to identify the fault. The second set of relay contacts for the four speed-reducer gear assembly oil flow sensors and two scr assembly fuse circuits are series-connected to minor drive fault relay K10. This relay is energized by 26 V dc applied through the six contact sets and provides a contact closure externally to indicate a minor drive fault should any monitored relay open. Relay K15 prevents a minor drive fault indication when an scr operate command is lost.

2-22. Minor Fault Summary Circuit (fig. FO-16, sh 2). The minor fault summary circuit contains relays and indicators to provide a front panel display of air conditioner temperature status, overtemperature status of high pass transmit filter in the feed group, and feed gro nitrogen pressure status. The minor fault summary c cuit relays operate in the same manner as the minor dr fault relays (subpara 2-21 above). In addition, the min fault summary relay contacts, when energized, are ser connected to minor drive fault status relays to apply ex tation to minor fault summary relay K11. When deene ized, these relays provide a contact closure externall indicate a fault. Thus, any minor drive fault will be su marized with minor fault summary faults and will the fore produce both an antenna minor drive fault sta signal and an antenna minor fault summary status sig

2-23. Stow Pin Control (fig. FO-16, sh 1). T identical relay and switch circuits are used for azim and elevation stow pin control. Only the azimuth circ is discussed. The antenna azimuth axis, when aligned the proper position for insertion of the azimuth stow p actuates the external azimuth axis aligned switch to p vide 26 V dc to azimuth STOW and RETRACT pushb ton indicator switches. The azimuth axis aligned swi thus prevents activation of the stow function at other th the proper position. Assuming the stow pin is retract the switch in the linear electromechanical actuator closed, providing 26 V dc to energize azimuth retr relay K9 and illuminate the AZIMUTH RETRACT dicator. Pressing the AZIMUTH STOW switch prov the azimuth stow command signal to the stow pin act tor and a stow signal to system status logic unit 15A5. T stow pin, in moving from the retract position, opens AZIMUTH RETRACT switch to denergize K9 and t off the RETRACT indicator. Since the stow pin is not in position, the stowed switch is also open and K deenergized. The AZIMUTH IN TRANSIT indica lights with both K8 and K9 deenergized to indicate stow pin is between the stow and retract positions. W the stow pin becomes fully engaged in the stow posi the stowed switch closes to energize K8, turn off AZIMUTH IN TRANSIT indicator, and light the IMUTH STOW indicator. The procedure for retrac the stow pin is similar when the azimuth retract comm is provided by the AZIMUTH RETRACT switch.

SECTION VI. CIRCUIT ANALYSIS OF DIRECT CURRENT CONTROL HTA-9

2-24. Assembly Circuit Analysis (fig. FO-17, FO-18). Direct current control HTA-9 (fig. FO-17) provides the control electronics and drive power for the azimuth and elevation antenna drive assemblies. The control electronics are contained in two identical electronic control amplifiers A2 and A3 and power supply control A1. Input ac drive power is applied through cabinet-mounted contactors K1 and K2 to the electronic control amplifiers. Output dc drive power is applied through cabinet-mounted power inductors L1 through L4. The remaining electrical equipment consists of cabinet-mounted power-on flasher DS1/DS2, door interlock switch S1, and fan motor B1. All control and monitor signals for the direct current control are routed by means of cables to terminal boards TB1 through TB4 on each of the electronic control amplifiers (see fig. FO-18). Three-phase, 480/277 V ac input drive power is applied directly from the ac distribution box to the contactors and power supply control. Three-phase, 120/208 V ac operating power is applied directly from the ac distribution box to the power supply control.

NOTE

For specific interunit cabling details, refer to cabling diagrams in TM 11-5895-898-12 or TM 11-5895-899-12. Internal cabling details are provided by figure FO-18.

2-25. Electronic Control Amplifier HTA-9A2,9A3 Circuit Analysis (fig. FO-19, FO-20, FO-21). Two identical electronic control amplifiers A2 and A3 provide control and monitor signal interfaces between external azimuth and elevation servo and control equipment and direct current control HTA-9 (see fig. FO-19 and FO-20). Electronic control amplifier circuit card assemblies A2A1 and A3A1 provide the electronics to implement the control functions and controls to operate the antenna in the local mode (see fig. FO-21). Local-remote operation may be implemented by connecting a remote control box to receptacle J4 located on the circuit card. Control functions include interlocks, local control, and drive power generation. Monitor functions include direct current control self-test (major fault detection), ac input phase reference test, and scr fuse fail/motor drive current overload sense (minor fault detection). Additional monitoring is provided by light emitting diodes (LED) on the circuit ard assembly.

a. Local Control Circuits (fig. 2-6). Local SLEW otentiometer R110 provides a nonlinear voltage divider etween the +15 V dc and -15 V dc inputs to simulate a gh velocity command signal. The nonlinearity is such at a large movement of the potentiometer wiper near e zero point produces only a slight change in velocity mmand output, whereas the same movement at or near the wiper extremes produces a very large change in velocity command output. The low signal is derived from chassis ground, which is common to the 15 V return. The local slew signal is applied through the SLEW position of LOCAL switch S1 and through the LOCAL position of OPERATE switch S2 to the drive power generation circuits discussed below. A calibrated local test velocity command or a remote test signal may be input through VEL TEST INP test points TP17 and TP18 with LOCAL switch in the TEST/REMOTE position.

b. Interlock Circuits (fig. FO-22). Electronic control amplifiers provide interlock circuits for remote and local operation and contacts for interlocks located in speed reducer gear assemblies and antenna drive assemblies.

(1) Remote-console (normal) operation of the antenna through direct current control HTA-9 is enabled when OPERATE switches S2 on both circuit card assemblies are set to NORMAL. When both electronic control amplifier OPERATE switches are set to NORMAL, switch segment S2D provides an azimuth and elevation scr normal status signal to antenna position and status panel 14A7. A second segment (S2C) completes a path for the scr operate command on TB1-7 to a fail relay K3 contact. If a failure is sensed by the fail logic, the fail relay is deenergized and a contact opening provides an azimuth or elevation scr failure excitation status through TB1 to antenna position and status panel 14A7. With no failure sensed, the fail relay is energized, and the scr operate command is applied through the closed relay contacts of K3 to contacts of manual brake relay K5. If the brakes have been manually released, one set of relay K5 contacts provides a brakes manually released status signal to the antenna position and status panel. The 26 V dc from the servo power supply assembly is applied through electronic control amplifier terminal board connections TB3 to the normally closed, series-connected brake release switches and back to manual brake relay K5. When energized, relay K5 completes a path for the scr operate signal to energize brake control relay K6. With brake control relay K6 energized, 26 V dc is provided to series-connected, solenoid-operated, brake release switches on the antenna drive assemblies and to brake operate relays K1 and K2 on the power supply control.

(2) The scr local enable signal from the antenna position and status panel is applied through the electronic control amplifier and power supply control terminal board connections to door interlock switch S1. With the door closed or the interlock switch bypass engaged, the scr local enable signal is sent to the power supply control to energize interlock relay A1K3 and to the electronic control amplifiers to light INTLK OK indicator DS18 on the circuit card assembly. Interlock relay A1K3 connects 120/208 V ac, 3-ph power to blower motors and direct current control equipment. Phase A/B of the 120/208 V ac power is applied through brake operate relays A1K1

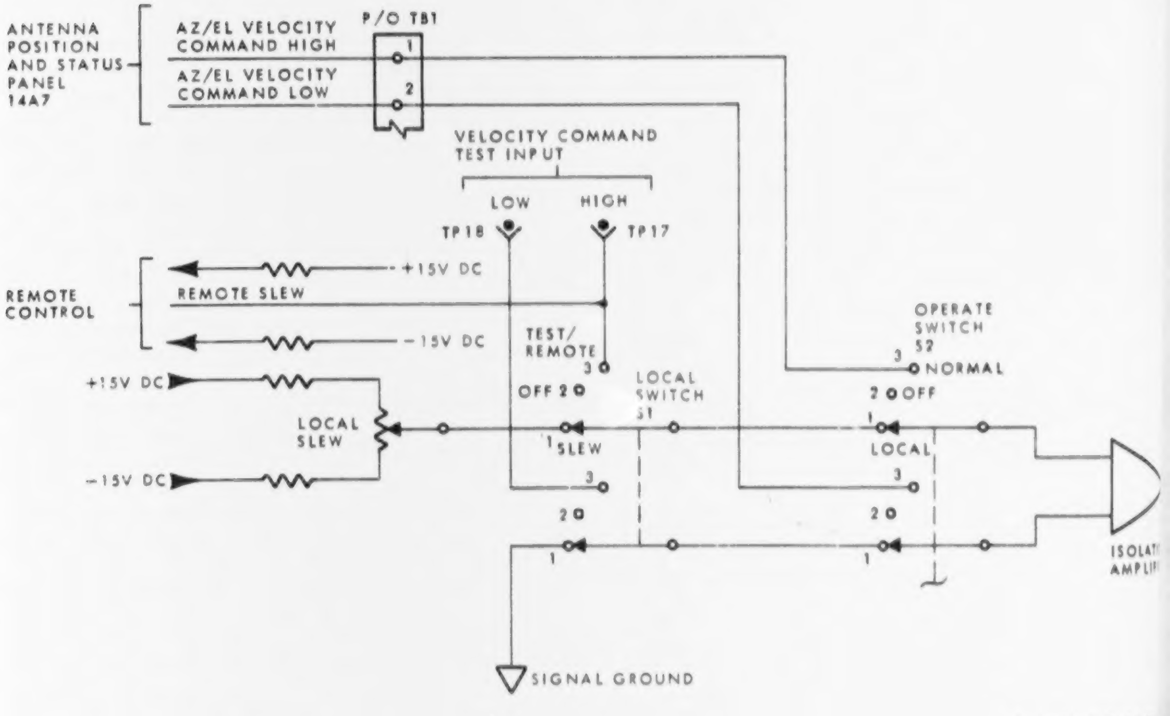

ANTENNA POSITION AND STATUS PANEL 14A7
AZ/EL VELOCITY COMMAND HIGH
AZ/EL VELOCITY COMMAND LOW
P/O TB1
1
2
VELOCITY COMMAND TEST INPUT
LOW
HIGH
TP18
TP17
REMOTE CONTROL
+15V DC
REMOTE SLEW
−15V DC
TEST/ REMOTE
3
OFF 2
LOCAL SWITCH S1
1 SLEW
3
2
1
+15V DC
LOCAL SLEW
−15V DC
OPERATE SWITCH S2
3 NORMAL
2 OFF
1 LOCAL
3
2
1
SIGNAL GROUND
ISOLATI
AMPLIF
EL5895-915-34-

Figure 2-6. Electronic control amplifier HTA-9A2,9A3 local control circuits, simplified schematic diagram

and A1K2 to both brakes in either axis. This action enables the brake solenoids that release the electric disk brakes and close the brake release switches. With the brake release switches closed, a path is completed for 26 V dc to speed reducer gear assembly oil pump relays in distribution box HTA-8A25 and also to the circuit card assembly as an amplifier-on signal. The amplifier-on signal lights AMPL ON indicator DS17 and energizes integrators uncage/trigger lockout relays K1 and K2.

(3) Local operation is enabled by setting OPERATE switch S2 on circuit card assembly A1 to LOCAL and LOCAL switch S1 (near S2) to SLEW. In the local mode, the azimuth and elevation scr normal status signal is inhibited and the scr local enable signal received through door interlock switch S1 is applied through remote brake control photo transistor U44 on the circuit card assembly, and the LOCAL contact of operate switch S2 to fail relay K3 contact. When no failures are sensed, fail relay K3 provides the scr operate command to manual brake relay K5 contacts. All other interlocks function as in remote operation (described in subparagraphs (1) and (2) above.

(4) Dc drive motor and speed reducer gear assembly status interlocks monitor dc drive motor heat and speed reducer gear assembly handcrank engaged status, and apply the respective status signals through electronic control amplifier terminal board connections to the antenna position and status panel. A pressure switch on each gear box monitors oil flow in the assembly and applies the status signal through electronic control amplifier terminal board connections to the stow pin control/minor fault summary panel HTA-8A24.

*c. **Drive Power Generation Circuits (fig. FO-23).*** Drive power for the dc drive motors is generated identically for each axis by the respective electronic control amplifier. As shown on figure FO-19, a velocity command from antenna position and status panel 14A7 or a local velocity command is applied through operate switch S2 on circuit card assembly A1 to the drive power generation circuits. A simplified schematic of the drive power generation circuits is provided in figure FO-23. The velocity command signal is bipolar and variable within the limits of plus or minus 10 V maximum. A positive velocity command voltage commands the antenna to drive clockwise in azimuth or up in elevation. In the following discussion, a positive velocity command signal representing clockwise drive for the azimuth electronic control amplifier is described. The discussion is directly applicable to an up-velocity command for the elevation electronic control amplifier. Inverting the polarity of the bipolar signals describes counterclockwise or downdrive for the applicable electronic control amplifier. Resistors, capacitors, and diodes are omitted in figure FO-23 to simplify functional description. All referenced components are shown on the schematic diagram (fig. FO-21).

(1) ***Tachometer loop summing.*** The velocity command signal is applied through compensation resistors R115 and R116 to isolation amplifier AR8(a). AR8(a) is an inverting, unity gain, differential input, operational amplifier. A positive velocity command signal is inverted by the isolation amplifier and applied through resistor R94 to summing points at the input to tachometer summing amplifier AR8(b). The dc tachometer-generator velocity feedback signals generated in the antenna drive assemblies are bipolar, dc voltages that are positive for clockwise antenna rotation and negative for counterclockwise antenna rotation. The dc tachometer-generator output gradient is ±100 V/1000 r/min (nominal) or 175 V/degree/second of antenna rotation. The dc tachometer-generator velocity feedback signals are coupled through divider networks R155/R150 and R157/R151 to unity gain, buffer operational amplifiers AR11 (a and b). Trimpots R150/R151 permit adjustment of the dc tachometer-generator output gradient to compensate for tolerances inherent in the dc tachometer generators. The divider networks divide each velocity feedback input by a factor of 17.5, providing motor 1 current feedback signals of 10 V/ degree/second of antenna rotation at AR11 outputs. The motor 1 current feedback signals are applied through compensation assemblies C19/R119 and C30/R120 to summing points at the input to tachometer summing amplifier AR8(b). The current feedback signals are also applied through resistors R137/R128 to differential amplifier AR10(b). The positive current feedback signals (for clockwise azimuth drive) are summed with the negative velocity command signal and the resultant signal is applied to tachometer summing amplifier AR8(b). Amplifier AR8(b) integrates the sum and applies a torque command through R96 to a summing point at the input to current limit amplifier AR9(a). The torque command is also applied through inverter AR10(a) to a summing point at the input to current limit amplifier AR9(b) in the motor 2 circuit. The tachometer summing amplifier (integrator) is caged (clamped to 0 V output) by relay K1 during turn-on and turn-off. Resistor R95 and relay K1 contacts provide a low resistance path between the input and output of the integrator until the amplifier-on signal energizes the relay to permit normal operation. Positive velocity feedback signals are applied to differential amplifier AR10(b), dc tachometer-generator 1 to the inverting input, and dc tachometer-generator 2 to the noninverting input. The output of amplifier AR10(b) (delta tach) is the difference between the dc tachometer-generator 1 and 2 velocity feedback inputs. The delta tach output signal is applied to both motor 1 and motor 2 limit amplifier summing points through resistors R100 and R101.

NOTE

Motor 1 and motor 2 limit amplifiers and circuits and all subsequent functions are identical.

(2) ***Firing angle limit and torque loop summing.*** Diode bridge CR39 through CR44 receives 3-ph timing reference voltages from the phase-shift filter network, full-wave rectifies all three phases, and applies the dc voltages to differential summing amplifier AR12(a). The differential summing amplifier output is a positive voltage and is a composite of the three timing reference voltage inputs. The amplitude of the output is proportional to the 480/277 V ac line voltage. The output is applied to unity gain inverting amplifier AR7(a). Trimpot R85 provides a voltage divider in the feedback loop of AR7(a) and permits fine adjustment of the integrator limit output signal. The integrator limit signal is applied directly through inverter AR7(b) to the transistor/diode limit network around amplifier AR5(a). The limit signal is compared with AR9(a) output across resistors R54 and R55. The difference is applied to the bases of transistors Q1 and Q2, which clamp the amplifier output. Diodes CR42 and CR43 protect the base-emitter junctions of the transistors from transients. Resistors R49 and R50 limit the current through the collector-emitter junctions of the transistors. Motor armature current is sampled at each motor and fed back through amplifier AR1(a) and compensating network to the integrator summing point. Amplifier AR1(a) is an inverting, operational amplifier, with a gain of 50. Trimpots connected to -15 V dc provide offset voltage adjustment for the amplifiers. The composite motor current feedback, firing angle limit, and motor torque signal is applied to firing limit integrator AR5(a). Integrator AR5(a) integrates the sum and applies firing angle error voltages through compensation amplifier AR5(b) to comparators AR2(a), AR2(b), and AR3(a). The firing angle integrators are caged (clamped to 0 V output) by relays K1 and K2 during turn-on and turn-off. Resistor R80 and relay contacts provide low resistance paths between the inputs and outputs of the integrators until the amplifier-on signal energizes the relays to permit normal operation.

(3) ***Comparison.*** The integrator-to-comparator coupling matches each integrator output to three comparator inverting inputs. The noninverting inputs are coupled to the phase reference voltages from the phase shift network. The phase shift network consists of three identical circuits. Phase A reference circuit consists of buffer operational amplifier AR12(b) and a filter group; phase B and C reference circuits consist of operational amplifiers AR13 (a and b) and filter groups. The phase shift filter network receives its inputs from the 480/277 V line, through 3-ph step-down transformer T1. The transformer secondary voltages are applied to the phase shift circuits on circuit card assembly A1, where each voltage phase is shifted by approximately 124 degrees an attenuated to approximately 10.2 V peak. The phase A B, and C reference voltages are applied to a phase refe ence check circuit (described in subpara 2-25*d* below), t an integrator limit circuit (described in subpara 2-25e(2) above), and to comparators AR1 (3 and 4). The firi angle input to each comparator is compared with th phase reference signal to that comparator. When the fi ing angle signal to a comparator is zero, the comparat zero-detects the shifted phase input to produce a symme trical square-wave logic level output. As the firing ang signal goes positive, the comparator output becomes mor asymmetrical, remaining low for a greater portion of th period. The opposite is true for a negative firing ang signal, which produces a high output for a longer dur tion. The output asymmetry is inversely proportional the firing angle input voltage. The comparator output clamped to the logic level (5 V max) by zener dio CR26, CR27, or CR29. Each comparator output applied to a pulse shaping network.

(4) ***Pulse-shaping/trigger lockout.*** Pulse shapi is implemented by NOR gates U7 (a through d), U8 through d), and U9 (a through d); inverters U12 through f), U13 (a through f), and U14 (a through f); a capacitors C9 through C20. Trigger lockout is imp mented by NAND gates U2 (a through d), U3 (a throu d), and U4 (a through d).

(**a**) The square-wave output of each compa tor is applied to two NOR-gate circuits. Each NOR g requires two logic low inputs to provide a logic high ou put. This occurs at intervals determined by the asymme ry and timing of the 3-ph inputs. At a specific NOR-g pair, the leading edge of a negative-going, asymmetric square-wave input is applied to one input of the applica NOR gate. The same signal is inverted and applied to t other input of the NOR gate, and is capacitive coup to ground. Conduction of the positive signal through capacitor causes the NOR gate input to remain low u the capacitor is charged to a positive level. The ti interval between high-to-low transition of the compar output signal and 2.2 ms charging time of the inver signal provides the two low signals necessary to activ the NOR gate. At the next transition of the compar signal, the positive-going signal is inverted twice to p vide exact logic conditions to the other NOR gate of pair. When either NOR gate receives two logic low puts, it provides a high output signal to the trigger lockout NAND gate.

(**b**) The trigger lockout signal is applied to input of all 12 NAND gates U2 (a through d) throu U4 (a through d). Trigger lockout is held high du normal operation by relay K1 and NAND gate U1 (a b). K1 is controlled by the amplifier-on signal. When is energized, both gates to U1 (a and b) are at logic The inverse outputs are applied to one input of each of 12 trigger lockout NAND gates U2 through U4. At t off, whether selected or automatic, the relay is dee ized, providing a contact closure and thus a logic low signal to the trigger lockout NAND gates, inhibiting all 12 gates to prevent firing of the scr's. When trigger lockout is a logic high, the gate is enabled, allowing the trigger pulses to control the gate.

(5) ***Scr assembly A2A2 through A2A7 and A3A2 throughA3A7 (fig. 2-7).*** Each electronic control amplifier contains six scr assemblies. Each scr assembly consists of two gate driver modules and two scr modules (see fig. 2-7). The gate driver modules are triggered by pulsed outputs from the pulse shaping circuits and in turn provide output pulses that trigger the scr modules.

(a) ***Gate driver module.*** The gate driver module operates a 25 kHz power-blocking oscillator and provides 2500 V dc isolation between input and output. Power input of +15 V dc is received from the special gate driver module power supply in power supply control A1. Control input is a +5 V dc logic level signal from the pulse shaping circuits. A logic low input triggers the gate driver module on. The gate driver module output is a full-wave rectified square wave.

(b) ***Scr module.*** The scr modules are connected in pairs, with each pair supplied by a phase of 480/277 V line voltage. Each pair is protected from line voltage by panel mounted, 100 A fuses F4 through F9. Fuse alarm circuits are described in subparagraph 2-25*e* below. Scr module 1 of A2, A3, and A4 supplies positive current for dc drive motor 1 antenna drive, and scr module 2 of A2, A3, and A4 supplies negative current for dc drive motor 1 antenna drive. Scr module 1 of A2 is triggered on during the positive excursion of phase A upon receipt of a gate turn-on pulse from the associated gate driver module. Scr module 2 of A2 is triggered on during the negative excursion of phase A upon receipt of gate turn-on pulse. The scr modules remain on to supply phase A armature current until the phase B scr module turns on, forcing the phase A scr module off. The same situation occurs with the other scr modules being controlled by phases B and C.

(6) ***Coupling and overload sensing.*** The scr assembly output is applied through power inductors L1 and L3 (azimuth) or L2 and L4 (elevation) and through overload relays K1 and K2 to the antenna drive assembly motors. The power inductors provide coupling between the positive and negative scr modules to provide a linear relationship between control voltage and output voltage. Current from scr modules A2 through A4 is applied to pposite terminals of L1 or L3 and the center-tapped output is applied through K1 to dc drive motor 1 armature. Current from A5 through A7 is applied to opposite erminals of L2 or L4 and the center-tapped output is pplied through K2 to dc drive motor 2 armature. Over-ad relays K1 and K2 contain heaters HR1 and HR2, through which the drive power is routed. Each heater controls a set of contacts which provides a contact opening when overheating is sensed by current sensor HR1 or HR2. The contacts apply +15 V dc to the respective gate driver modules and to motor overload indicating circuits on the circuit card. The effect of the overload voltage at the gate driver module is to inhibit the trigger output and thus remove the drive power and motor overload condition. When the sensor cools, the contacts close and drive power is automatically reapplied to the dc drive motor. The opposite dc drive motor continues to operate during an overheat condition unless the thermal switch located in the motor is also triggered, in which case a motor hot major alarm is indicated. Armature current is returned to the neutral line through 200 mV, 100 A shunts R4 and R5. Shunt current is used to provide motor current feedback to the torque loop summing network (subpara 2-25 c(2) above).

*d. **Major Fault Detection (fig. FO-24).*** The major fault detection circuits monitor power supply control power outputs, motor field power, 3-ph reference power, and servo power supply +26 V dc output. Power supply control power outputs are dual 15 V dc, +5 V dc, and +15 V dc gate drive modules.

(1) The positive and negative 15 V inputs at pins 9 through 11 of TB2 are applied through dropping resistors R66 and R67 to phototransistors U23 and U24 and LED's DS9 and DS10, lighting the LED's. Line capacitors C42 and C44 provide ripple bypass for the phototransistors. The +15 V dc and -15 V dc LED's provide local indications of a failure to assist in direct current control troubleshooting. The phototransistors are turned on by the +15 V dc and -15 V dc and thus provide low resistance, collector-to-emitter paths for inverter group inputs. The logic low input to each inverter group U22/U29 provides a logic high output, back-biasing diodes CR21 and CR22 and providing logic high's to expansion-type NAND gate U25.

(2) The gate driver module +15 V dc output at pins 7 and 8 of TB2 is applied through dropping resistor R26, phototransistor U40 and +15 V GATE LED DS12 to light DS12. Line capacitor C1 provides ripple bypass for the phototransistors. The +15 V GATE LED provides a local indication of a failure to assist in direct current control troubleshooting. Phototransistor U40 is turned on by the +15 V dc and thus provides a low resistance, collector-to-emitter path for inverter group U39 input. The logic low input to the inverter group provides a logic high output, back-biasing diode CR20 and providing a logic high to NAND gate U25.

(3) Field voltages at pins 17 through 19 of TB2, derived from field current through a 3-ohm resistor, are applied through dropping resistors R43 and R44 to phototransistors U35 and U36. Diodes CR23 and CR24 provide polarity reversal protection for the phototransistors. The phototransistors are turned on by the field voltages

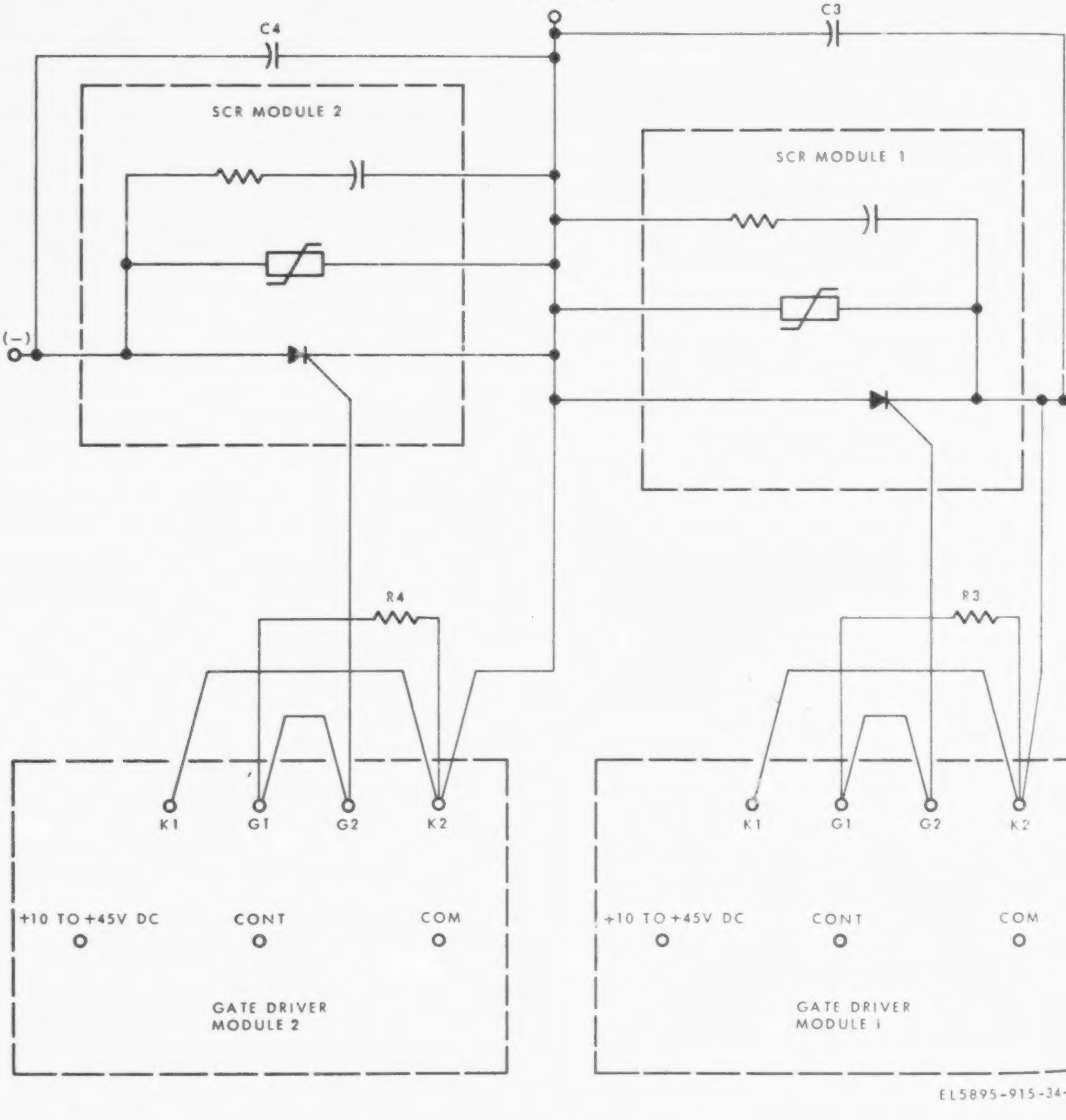

AC TERM
C4
C3
SCR MODULE 2
SCR MODULE 1
(−)
R4
R3
K1
G1
G2
K2
K1
G1
G2
K2
+10 TO +45V DC
CONT
COM
+10 TO +45V DC
CONT
COM
GATE DRIVER
MODULE 2
GATE DRIVER
MODULE 1
EL5895-915-34-

Figure 2-7. Scr assembly HTA-9A2A2 through 9A2A7 and HTA-9A3A3 through 9A3A7, schematic diagra

and thus provide low resistance, collector-to-emitter paths for inverter group U38 inputs. The logic low input to each inverter group provides a logic high output to NAND gate U25. The logic highs are again inverted by U17 to provide forward biasing of MOT 1 FLD and MOT 2 FLD LED's DS7 and DS8 to light the LED's. Local indications of failure are provided by the LED's to assist in direct current control troubleshooting.

(4) Three-phase ac reference voltages are applied through voltage dividers R90 and R91 and phase shifter R92/C34 to noninverting inputs of buffer operational amplifiers AR14(a) and AR14(b). With all three phases present and in the right sequence, there is no potential difference between outputs of the buffer operational amplifiers. This keeps phototransistors U42 and U43 turned off and provides a high resistance, collector-to-emitter path for inverter group U39/U29 input. The logic high input to the inverter group provides a logic high output, that back-biases diode CR19 and provides a logic high to NAND gate U25. The logic high is also presented to inverter group U29, which inverts the signal input twice to provide back biasing of PHASE REF LED DS14. If U42 or U43 is turned on, due to a phase difference at AR14, a low collector-to-emitter resistance provides a low to U39/U29 inverter group. The logic low to the inverter group, inverted four times, provides a logic low output, forward-biasing CR19. The low signal is applied to U25 (subpara 2-25*d*(5) below) and to PHASE REF LED DS14, turning DS14 on. The LED provides a local indication of a failure, to assist in direct current control troubleshooting.

(5) When all signals to NAND gate U25 pins 1 through 6 are high, a logic low at the output turns on phototransistor U45, which provides a low resistance, collector-to-emitter path for scr fault relay K3 through forward biased diode CR43. This action energizes K3 and provides energizing voltages to external relays, indicating normal operation. The opposite occurs when any low is presented to U25.

(6) A +5 V dc power supply failure is sensed by phototransistor U45 turn-off, which then deenergizes scr fault relay K3. The loss of +5 V dc at pins 12 and 13 of TB2 is indicated by +5 V LED DS11.

(7) A 26 V dc power supply failure is sensed by scr fault relay K3, which deenergizes. The loss of +26 V dc at pins 3 and 4 of TB1 is indicated by +26 V LED DS13. Scr fault relay K3 senses any power failure and provides an scr failure signal to antenna position and status panel 14A7.

e. Minor Fault Detection (fig. FO-25). Scr fuses F4 through F9 and overload relays K1 and K2 provide overload status for dc drive motor armatures and associated equipment.

(1) ***Overload detection.*** Gate driver module +15 V dc from power supply control HTA-9A1 is applied through pin 7 of TB2 to the normally closed contacts of both drive current overload relays K1 and K2. When drive current is normal, the overload status excitation voltage is applied to the gate driver modules and through current limiting resistors R27 and R28 on the circuit card assembly to phototransistors U31 and U32. The phototransistors are both turned on, permitting conduction through the collector-to-emitter junctions and providing logic low signals to inverter groups U30. Logic lows to the inverter groups are inverted three times to present high signals to gates 1 and 2 of NAND gate U15. MOT 1 OVLD and MOT 2 OVLD LED's DS15 and DS16 are back-biased and the indicators remain off. With the input signals high, U15 presents a logic low to phototransistor U41, which turns it on to provide a conduction path for motor overload relay K8 excitation voltage. If K1HR1 or K2HR2 senses an overcurrent condition, the respective overload sense relay opens and the voltage to U31 and U32 is removed, turning off the applicable phototransistor, turning on the associated overload LED, and presenting a low to a U15 gate. When the overload condition is relieved, the circuit is automatically restored to normal. An excitation voltage from stow pin control/minor fault summary panel HTA-8A24 is applied through pin 5 of TB2 to relay K8 wiper contact. When K8 is energized (no overload sensed), closed contacts apply the scr fuse failure excitation to the wiper contact of fuse failure relay K4.

(2) ***Fuse failure detection.*** Each phase of internal 480/277 V ac, 3-ph power is applied through a 100 A fuse to an scr assembly and through a dropping resistor (R6 through R11) to a phototransistor (U1 through U6) on the circuit card, causing the phototransistor to conduct. When conducting, the phototransistor provides a group (logic low) path through the collector-to-emitter junction. The logic low is presented to one input gate of NAND gate groups U7/U8 and U14/U15. U7 provides a logic low at pin 6. The same low signal at the photodiode is applied through inverter group U9/U13 to one input of another NAND gate (U7 pin 1, for example), the output of which (pin 3) is common to pin 6. In the example, U7 pin 1 input is compared with phase A reference input and if phase A fuse is good, a high is also presented to pin 2, providing a logic low at pin 3. The logic low is applied to inverter group U17/U18 or U16/U22 and after three inversions provides a high to expansion NAND gate U25. Any logic low to U25 back-biases the respective LED (DS1 through DS6) causing the LED to light, indicating the fuse that is blown. When all six fuse circuits are normal, the logic highs at NAND gate U25 inputs cause a low output that allows phototransistor U46 to conduct. When conducting, U46 provides a ground path for fuse fault relay K4 energizing voltage. Contacts of relays K8 and K4 are series connected to provide an OR function for motor overload and scr fuse failure circuits. Any overload or fuse failure condition causes one of the relays to open and remove the energizing voltage through TB2-6 to the applicable fuse failure relay in stow pin control/

minor fault summary panel HTA-8A24. The end result of a deenergized fuse failure relay is a minor drive fault indication on antenna position and status panel 14A7.

f. Circuit Card Assembly HTA-9A2A1,9A3A1 LED Indicators. LED indicators are provided on circuit card assembly A1 to aid in troubleshooting of the direct current control. Table 2-2 lists the LED's by stenciled name and provides the reference designation, color, and function for each.

Table 2-2 Circuit Card Assembly HTA-9A2A1, HTA-9A3A1 LED's

Name	Color	Ref des	Function
MOT 1 FLD	Yel	DS7	Monitors dc drive motor 1 field supply for applicable axis
MOT 2 FLD	Yel	DS8	Monitors dc drive motor 2 field supply for applicable axis
INTLK OK	Yel	DS18	Lights when door interlock switch is closed and scr local enable signal is received
MNL BK RLSE	Red	DS19	Lights when either electric disk brake for applicable axis is manually released
MOT 1 OVLD	Red	DS15	Monitors dc drive motor 1 armature current for overload for applicable axis
MOT 2 OVLD	Red	DS16	Monitors dc drive motor 2 armature current for overload for applicable axis
PHASE REF	Red	DS14	Monitors phase-shifted 277/480 V ac input for all three phases in correct phase rotation
AMPL ON	Yel	DS17	Lights when all direct current control HTA-9 functions are operative
MOTOR 1 PHA FU	Red	DS1	Monitors fuse F4 in scr A2 circuit
MOTOR 1 PHB FU	Red	DS2	Monitors fuse F5 in scr A3 circuit
MOTOR 1 PHC FU	Red	DS3	Monitors fuse F6 in scr A4 circuit
MOTOR 2 PHA FU	Red	DS4	Monitors fuse F7 in scr A5 circuit
MOTOR 2 PHB FU	Red	DS5	Monitors fuse F8 in scr A6 circuit
MOTOR 2 PHC FU	Red	DS6	Monitors fuse F9 in scr A7 circuit
+5 V dc	Yel	DS11	Monitors power supply PS1 in power supply control HTA-9A1 for +5 V dc output
+15 V dc	Yel	DS9	Monitors power supply PS2 in power supply control HTA-9A1 for +15 V dc output
-15 V dc	Yel	DS10	Monitors power supply PS2 in power supply control HTA-9A1 for -15 V dc output
+15 GATE	Yel	DS12	Monitors power supply PS3 in power supply control HTA-9A1 for +15 V dc output
+26 V dc	Yel	DS13	Monitors power supply PS1 in antenna position and status panel 14A7f or +26 V dc output

2-26. Power Supply Control HTA-9A1 Circuit Analysis (fig. FO-26, FO-27). Power supply control HTA-9A1 provides field voltages for all four dc drive motors in the antenna ancillary group, power control for cabinet-mounted contactors K1 and K2 and internal power supplies PS1 through PS3, and distribution for cabinet-mounted power-on flasher DS1/DS2 and antenna ancillary group accessories power.

a. Motor Field Voltage Generation. Phases A and B of 277/480 V ac, 3-ph input at TB2-17 through TB2-20 are applied through 5 A fuse assemblies XF1 through XF4 to half-wave rectifiers CR1 and CR2. Fuse assemblies XF1 and XF2 and rectifier CR1 are in the elevation field circuits; XF3, FX4, and CR2 are in the azimuth field circuits. Each fuse assembly contains a fuse and blown-fuse indicator. Rectifier outputs are applied through TB2-6 and TB2-8 (elevation) and TB3-6 and TB3-8 (azimuth) to motor 1 and motor 2 field windings. The return lines of each field voltage are routed back through TB2-7 and TB2-9 and TB3-7 and TB3-9 to line neutral. Resistors R1 through R4 in the return lines provide voltages through TB1-1, TB1-3, and TB1-8 through TB1-10 to the respective electronic control amplifier major fault detection circuit.

b. Power Control. Phase C of 120/208 V ac, 3-ph distribution is applied to both panel-mounted circuit breakers CB1 and CB2. CB1 provides control and 5.0 A protection for power supplies HTA-9A1PS1 through HTA-9A1 PS3 and cabinet fan motor B1. CB2 provides control and 5.0 A protection for cabinet-mounted contactors K1 (elevation) and K2 (azimuth).

c. Power Distribution. The 120/208 V ac 3-ph power received at TB3-17 through TB3-20 is distributed by relay K3 when +26 V dc is received from door interlock switch S1 through TB2-19. Motor blower 3-ph power is distributed to elevation drive motor assembly HTA-12A2,A4 through TB2-1 through TB2-3 and to azimuth drive motor assembly HTA-12A1,A3 through TB3-1 through TB3-3. Electric disk brake power, phases A and B, is also distributed to elevation and azimuth drive motor assemblies through TB2-4 and TB2-5 and TB3-4 and TB2-5 when respective relays K1 and K2 are commanded by brake relay operate +26 V through TB1-4 and TB-11. Phase C is also distributed internally to circuit breakers CB1 and CB2 and to cabinet-mounted power-on flasher DS1/DS2 through TB2-12. Power supply control HTA-9A1 provides continuous 120 V, 15 A phase C utility and test power to panel-mounted power outlet J1.

d. 5 V DC Power Supply HTA-9A1PS1 Circuit Analysis(fig. FO-28). The +5 V dc power supply provides a regulated +5 V dc output at 2.7 A and contains protective circuits for overcurrent conditions. The +5 V dc power supply consists of an ac input circuit, a main rectifier, a bias supply and a series voltage regulator circuit.

(1) ***Ac input circuit.*** Single phase 120 V ac input power is applied to transformer T1. Transformer T1, which contains two secondary windings, steps down input voltage for application to the main and auxil rectifiers.

(2) ***Bias supply.*** The bias supply provides ope ing voltages for the regulator circuits on integrated cir IC1. The bias supply consists of auxiliary rectifier (and filter capacitor C1. Auxiliary rectifier CR1 perfo half-wave rectification of ac voltage from step-down p er transformer T1 to provide a dc voltage that is filte by capacitor C1 and applied to pin 14 on integrated cuit IC1.

(3) ***Main rectifier.*** The main rectifier consis rectifiers CR3 and CR4 and filter capacitor C6. R tifiers CR3 and CR4 perform full-wave rectification o voltage from transformer T1 to provide a dc voltage is filtered by capacitor C6. The filtered dc voltag applied to series regulator Q2.

(4) ***Series voltage regulator.*** The series vol regulator circuit regulates the dc output voltage and vides overcurrent protection. The series voltage regu circuit is composed of emitter-follower drivers Q1 Q3, series regulator Q2, and integrated circuit IC1, w senses changes in output voltage and detects overcur conditions. Series regulator Q2 receives dc voltage the main rectifier and controls the output by prese a variable impedance in series with the load. The r lated 5 V dc output is taken across pins 6 and 4 of te nal board TB1. The dc output voltage is adjustable 4.75 V to 5.25 V by potentiometer R8. Fuse F1 pro the external load from power supply component fa Series regulator Q2, which regulates dc output voltag the adjustable value established by potentiometer R controlled by signals from integrated circuit IC1 tha caused by changes in output voltage or by overcu conditions.

(a) ***Normal load regulation.*** Operation o series voltage regulator circuit is determined by cha in the power supply output voltage. The output volta the power supply on pin 7 of terminal board TB applied to pin 9 on integrated circuit IC1. Integ circuit IC1 compares the output voltage with a cons reference voltage received at pin 8. The reference vo is developed by a constant current flow of 1 mA thr potentiometer R8 and resistor R20. When a chang output voltage is sensed, an error signal is applied pin 5 of integrated circuit IC1 to the base of em follower driver Q1. The error signal is successive rent amplified by drivers Q1 and Q3 to control ope of series regulator Q2. If for example, the load cu decreases, causing a rise in the output voltage, integ circuit IC1 provides a less positive error signal to the of driver Q1. This results in a decreased positive pot to be developed across resistor R5, reducing the for bias of series regulator Q2. With reduced forward series regulator Q2 presents increased impedance ca the output voltage to decrease.

(b) ***Overcurrent operation.*** Overcurrent condi- ons are detected by integrated circuit IC1, which com- ires output load current with a preset reference. The itput load current is sampled by current sensing resistor 22, which is in series with the output current path. The eset reference, which functions as a maximum output irrent threshold, is established by resistors R6 and R9 id applied to pin 10 of integrated circuit IC1. Under ormal load conditions, the voltage developed by resistor 22 is insufficient to overcome the preset reference and tegrated circuit IC1 does not function as an overcurrent evice. When the output current of the power supply ceeds the rated current value, the voltage drop across sistor R22 exceeds the preset reference voltage at the nction of resistors R6 and R9.

Vhen the voltage at pin 11 of integrated circuit IC1 ceeds the voltage at pin 10, integrated circuit IC1 uses a decrease in the current through drivers Q1 and 3, resulting in an increase of voltage across series regu- tor Q2 and a decrease of the output voltage, effectively niting the output current to a safe value. The current nit value is determined by fixed resistors R6, R9, and 22.

e. Dual 15 V DC Power Supply HTA-9A1PS2 Cir- it Analysis(fig. FO-29). Power supply PS2 is a modular ower supply that provides dual output voltages of +15 dc and -15 V dc at 0.5 A for each output. The +15 V and -15 V dc outputs are provided by separate, identi- l supplies that are adjustable within the range of 0 to 3 V. In addition to an ac input circuit that is shared by oth supplies, each power supply includes a bias supply, main rectifier, and a series voltage regulator circuit. ince both supplies are identical, only the +15 dc supply discussed in detail.

(1) ***Ac input circuit.*** Single-phase 120 V ac input ower is applied to transformer T1. Transformer T1, hich contains four secondary windings, steps down the put voltage for application to the main and auxiliary ctifiers for each power supply.

(2) ***Bias supply.*** The bias supply provides operat- g voltages for the regulator circuits on integrated circuit C1. The bias supply consists of auxiliary rectifier CR1 nd filter capacitor C1. Auxiliary rectifier CR1 performs alf-wave rectification of ac voltage from step-down pow- r transformer T1 to provide a dc voltage that is filtered y capacitor C1 and applied to pin 14 on integrated cir- uit IC1.

(3) ***Main Rectifier.*** The main rectifier consists of ridge rectifiers CR2 through CR5 and filter capacitor 6. Bridge rectifiers CR2 through CR5 perform full- ave rectification of ac voltage from transformer T1 to rovide a dc voltage that is filtered by capacitor C6. The ltered dc voltage is applied to series regulator Q2.

(4) ***Series voltage regulator.*** The series voltage egulator circuit regulates dc output voltage and provides vercurrent protection. The series voltage regulator circuit is composed of emitter-follower, driver Q1, series regulator Q2, and integrated circuit IC1, which senses changes in output voltage and detects overcurrent conditions. Series regulator Q2 receives dc voltage from the main rectifier and controls output voltage by presenting a variable impedance in series with the load. The regulated +15 V dc output voltage is taken across pins 6 and 4 of terminal board TB1. The dc voltage is adjustable from 0 V to 18 V with potentiometer R8. Fuse F1 protects the external load from power supply component failure. Series regulator Q2, which regulates the dc output voltage to the adjustable value established by potentiometer R8, is controlled by signals from integrated circuit IC1 that are caused by changes in output voltage or by overcurrent conditions.

(a) ***Normal load regulation.*** Operation of the series voltage regulator circuit is determined by changes in the power supply output voltage. The output voltage of the power supply on pin 7 of terminal board TB1 is applied to pin 9 on integrated circuit IC1. Integrated circuit IC1 compares the output voltage with a constant reference voltage received at pin 8. The reference voltage is developed by a constant current flow of 1 mA through potentiometer R8. When a change in output voltage is sensed, an error signal is applied from pin 5 of integrated circuit IC1 to the base of emitter-follower driver Q1. The error signal is successively current-amplified by driver Q1 to control operation of series regulator Q2. If for example, the load current decreases, causing a rise in the output voltage, integrated circuit IC1 provides a less positive error signal to the base of driver Q1. This causes a decreased positive potential to be developed across resistor R5, reducing the forward bias of series regulator Q2. With reduced forward bias, series regulator Q2 presents increased impedance, causing the output voltage to decrease.

(b) ***Overcurrent operation.*** Overcurrent conditions are detected by integrated circuit IC1, which compares output load current with a preset reference. The output load current is sampled by current sensing resistor R7, which is in series with the output current path. The preset reference, which functions as a maximum output current threshold, is established by resistors R6 and R9 and applied to pin 10 of integrated circuit IC1. Under normal load conditions, the voltage developed by resistor R7 is insufficient to overcome the preset reference and integrated circuit IC1 does not function as an overcurrent device. When the output current of the power supply exceeds the rated current value, the voltage drop across resistor R7 exceeds the preset reference voltage at the junction of resistors R6 and R9. When the voltage at pin 11 of integrated circuit IC1 (voltage drop across R7) exceeds the voltage of pin 10, integrated circuit IC1 causes a decrease in the current through driver Q1, resulting in an increase of voltage across series regulator Q2 and a decrease of the output voltage, effectively limiting the output current to a safe value. The current limit value is determined by fixed resistors R6, R9, and R7.

f. ±5 V DC Gate Power Supply HTA-9A1PS3 CircuitAnalysis (fig. FO-30). Power supply PS3 provides a regulated +15 V dc output at 2.2 A and contains protective circuits for overcurrent conditions. The +15 V dc power supply consists of an ac input circuit, a main rectifier, a bias supply and a series voltage regulator circuit.

(1) ***Ac input circuit.*** Single phase 120-V ac input power is applied through thermostat S1 to transformer T1. Thermostat S1 opens to protect the supply when overheating occurs and resets automatically when the overtemperature condition is eliminated. Transformer T1, which contains two secondary windings, steps down the input voltage for application to the main and auxiliary rectifiers.

(2) ***Bias supply.*** The bias supply provides operating voltages for the regulator circuits on integrated circuit IC1. The bias supply consists of auxiliary rectifier CR1, filter capacitor C1, and zener diode regulator CR21. Auxiliary rectifier CR1 performs half-wave rectification of ac voltage from step-down power transformer T1 to provide a dc voltage that is filtered by capacitor C1 and applied to pin 14 on integrated circuit IC1. Zener diode CR21, which is connected across the bias supply, provides a regulated, compensated reference voltage.

(3) ***Main rectifier.*** The main rectifier consists of bridge rectifiers CR2 through CR5 and filter capacitors C3 and C6. Bridge rectifiers CR2 through CR5 perform full wave rectification of the ac voltage from transformer T1 to provide a dc voltage that is filtered by capacitors C3 and C6. The filtered dc voltage is applied to series regulators Q3 and Q4.

(4) ***Series voltage regulator.*** The series voltage regulator circuit regulates the dc output voltage and provides overcurrent protection. The series voltage regulator circuit is composed of emitter-follower drivers Q1 and Q2, series regulators Q3 and Q4, and integrated circuit IC1, which senses changes in output voltage and detects overcurrent conditions. Series regulators Q3 and Q4 receive the dc voltage from the main rectifier and control the output by presenting a variable impedance in series with the load. The regulated 15 V dc output is taken across pins 6 and 4 of terminal board TB1. The dc output voltage is adjustable from 14.25 to 15.75 V dc by potentiometer R8. Fuse F1 protects the external load from power supply component failure. Series regulators Q3 and Q4, which regulate the dc output voltage to the adjustable value established by potentiometer R8, are controlled by signals from integrated circuit IC1 that are caused by changes in output voltage or by overcurrent conditions.

(a) ***Normal load regulation.*** Operation of the series voltage regulator circuit is determined by changes in the power supply output voltage. The output voltage of the power supply on pin 7 of terminal board TB1 is applied to pin 9 on integrated circuit IC1. Integrated circuit IC1 compares the output voltage with a constant reference voltage received at pin 8. The reference vol is developed by a constant current flow of 1 mA thro potentiometer R8 and resistor R20. When a change in output voltage is sensed, an error signal is applied f pin 5 of integrated circuit IC1 to the base of emit follower driver Q1. The error signal is successively rent amplified by drivers Q1 and Q2 to control opera of series regulators Q3 and Q4. If for example, the current decreases, causing a rise in output voltage, i grated circuit IC1 provides a less positive error signa the base of driver Q1. This results in a decreased pos potential being developed across resistor R16 redu the forward bias of drivers Q1 and Q2. With redu forward bias, series regulators Q3 and Q4 presen creased impedance, causing the output voltage to crease.

(b) ***Overcurrent operation.*** Overcur conditions are detected by integrated circuit IC1, w compares output load current with a preset reference output load current is sampled by current sensing re R7, which is in series with the output current path. preset reference, which functions as a maximum ov current threshold, is established by resistors R6 and and applied to pin 10 of integrated circuit IC1. U normal load conditions, the voltage developed by res R7 is insufficient to overcome the preset reference integrated circuit IC1 does not function as an overcur device. When the output current of the power su exceeds the rated current value, the voltage drop ac resistor R7 exceeds the preset reference voltage at junction of resistors R6 and R9. When the voltage a 11 of integrated circuit IC1 (voltage drop across exceeds the voltage at pin 10, integrated circuit causes a decrease in the current through drivers Q1 Q2, resulting in an increase of voltage across series r lators Q3 and Q4 and a decrease of the output vol effectively limiting the output current to a safe value current limit value is determined by fixed resistors R9, and R22.

2-27. Cabinet-Mounted Equipment Circuit scription. Electrical equipment mounted on the net consists of power inductors L1 through L4, conta K1 and K2, power-on flasher DS1/DS2, door inte switch S1, and fan motor B1. The power inductors shown on electronic control amplifier schematic, fi FO-20; all other cabinet-mounted equipment is show power supply control schematic, figure FO-27. The p inductor inputs are connected to the respective scr as bly outputs and the power inductor center tap output connected to the overload relays on each electronic trol amplifier. The power inductors provide coupling tween positive and negative scr assembly outpu improve control linearity. The contactor coils are nected to the power supply control through ter boards TB2 and TB3. The contacts are connected 277/480 V ac cable and to fuses on the electronic c amplifiers. The power-on flasher and door interlock connect to power supply control through TB2 and the fan motor is connected through TB3.

SECTION VII. CIRCUIT ANALYSIS OF ANTENNA ANCILLARY GROUP HTA-12

2-28. General. Antenna ancillary group HTA-12 consists of four drive motor assemblies HTA-12A1 through HTA-12A4. The assemblies are electrically and functionally identical. This section describes a typical antenna drive assembly.

2-29. Az/El Drive Motor Assembly 1 and 2 Circuit Analysis (fig. 2-8). Each antenna drive assembly consists of a dc drive motor, an electric disk brake, a dc tachometer-generator, and a motor blower. Connections to these subassemblies are made through terminal boards TB1 through TB4, located in junction boxes mounted on the assembly.

a. DC Drive Motor. The dc drive motor operates in response to dc drive power from direct current control HTA-9 to drive a speed reducer gear box, which in turn positions the antenna. The dc drive motor is 10-horsepower, continuous-duty, drip-proof shunt-wound, dc motor. The motor utilizes antifriction bearings and is capable of operating at a maximum speed of 2300 r/min. A thermal overload switch is built-in to protect the motor from excessive overheating caused by overloading or failure to start. The thermally operated switch is a single-pole, double-throw type. The normally closed contacts open when the motor temperature rises above a selected point and close when the motor temperature drops below this point.

b. Motor Blower. The motor blower provides cooling air to dc drive motor B1 and consists of a fan driven by a 1/3 horsepower, 3-ph, ac motor. The fan operates continuously and independently of the drive motor.

c. Electric Disk Brake. The electric disk brake is a fail-safe type in that it is spring set and electrically released. The brake is released by action of a solenoid mounted within the brake housing. A coil-spring clutch provides automatic correction of the solenoid air gap to compensate for friction disk wear and thermal expansion. The solenoid is single-phase connected to phases B and C. When power is applied, the solenoid releases the disk brakes to allow movement of the dc drive motor shaft. A solenoid activated brake switch closes to communicate release of the brakes to direct current control HTA-9 and to allow operation of the servo and control equipment. In a similar manner, when power is removed from the solenoid, the brakes are set and the brake switch opens to inhibit the servo and control equipment. The brake may be manually released by a manual release lever located on the brake housing. When the brake is manually released with the lever, the single-pole double-throw manual brake release switch opens to communicate that action to the direct current control.

d. DC Tachometer-Generator. The precision dc tachometer-generator has a ball-bearing-mounted rotor shaft and a totally enclosed dc generator. The dc tachometer-generator is coupled by an adapter to the backshaft of the electric disk brake, which in turn is coupled to the dc drive motor shaft. The tachometer-generator provides a dc output of 100 V/1000 r/min, which is directly proportional to the speed of the motor shaft. The dc output voltage is used as current feedback by direct current control HTA-9.

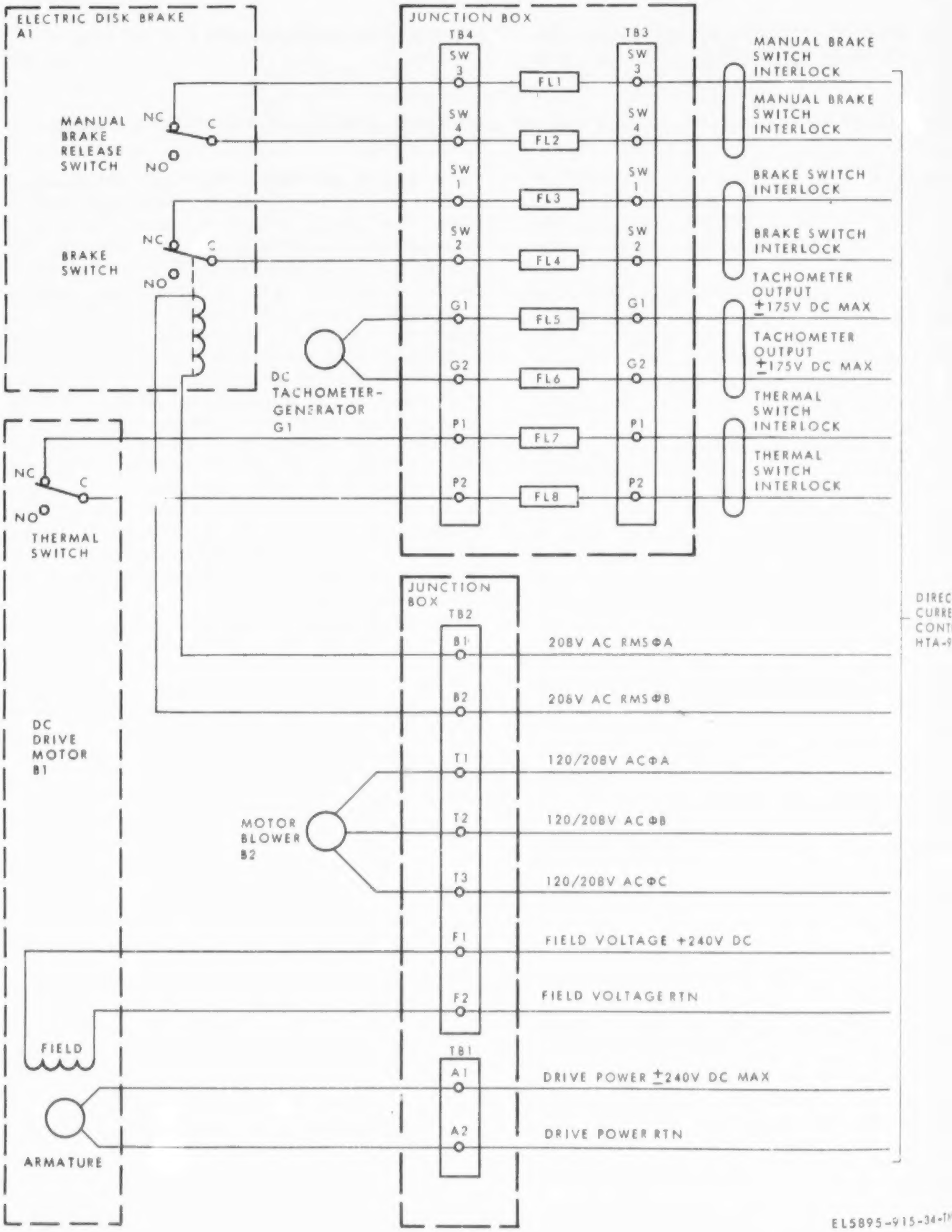

ELECTRIC DISK BRAKE
A1
MANUAL BRAKE RELEASE SWITCH
NC
C
NO
BRAKE SWITCH
NC
C
NO
DC TACHOMETER-GENERATOR
G1
NC
C
NO
THERMAL SWITCH
DC DRIVE MOTOR
B1
FIELD
ARMATURE
JUNCTION BOX
TB4
TB3
SW 3
SW 4
SW 1
SW 2
G1
G2
P1
P2
FL1
FL2
FL3
FL4
FL5
FL6
FL7
FL8
MANUAL BRAKE SWITCH INTERLOCK
MANUAL BRAKE SWITCH INTERLOCK
BRAKE SWITCH INTERLOCK
BRAKE SWITCH INTERLOCK
TACHOMETER OUTPUT ±175V DC MAX
TACHOMETER OUTPUT ±175V DC MAX
THERMAL SWITCH INTERLOCK
THERMAL SWITCH INTERLOCK
JUNCTION BOX
TB2
B1
B2
T1
T2
T3
F1
F2
TB1
A1
A2
MOTOR BLOWER
B2
208V AC RMSΦA
208V AC RMSΦB
120/208V ACΦA
120/208V ACΦB
120/208V ACΦC
FIELD VOLTAGE +240V DC
FIELD VOLTAGE RTN
DRIVE POWER ±240V DC MAX
DRIVE POWER RTN
DIREC
CURRE
CONT
HTA-9
EL5895-915-34-T

Figure 2-8. Azimuth/elevation drive motor assembly 1 and 2, HTA-12A1 through 12A4, schematic diagram.

SECTION VIII. CIRCUIT ANALYSIS OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 and HTA-6A6A1

2-30. General. Each of the two operating antenna axes is physically connected to a data module gear arrangement (fig. 1-7 and 1-8). Data modules HTA-8A7A1 and HTA-6A6A1 are electrically identical. A slight functional difference will be noted below, otherwise only a typical data module will be discussed here. The data module consists of a cam-operated limit switch, two synchro control transmitters, a synchro torque transmitter, and a gear box.

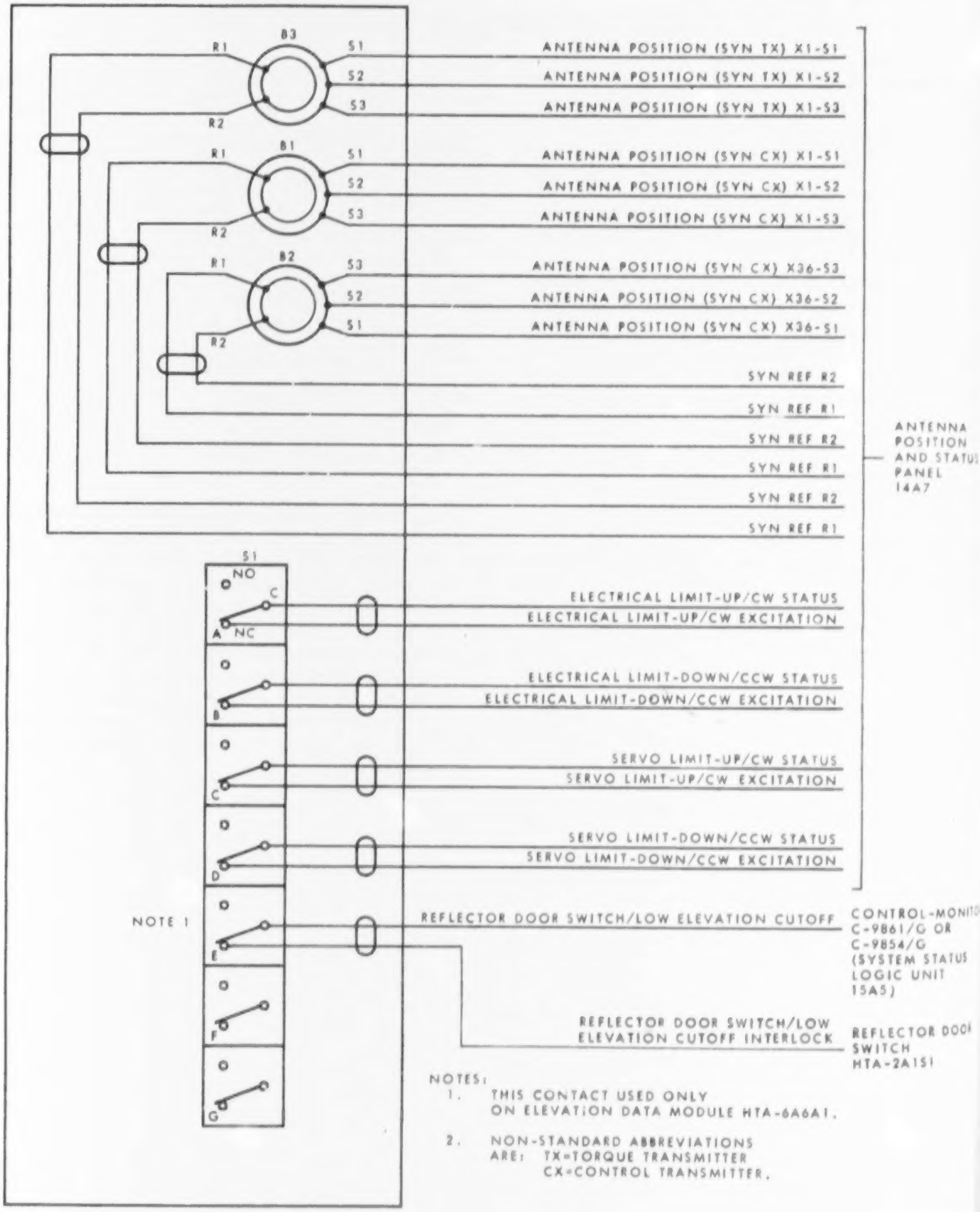
2-31. Limit Switch Circuit Analysis (fig. 2-9). Limit switch electrical contacts (segments A through D of azimuth data module HTA-8A7A1 and segments A through E of elevation data module HTA-6A6A1) open when antenna travel reaches any of the following typical preset limit conditions.

NOTE

Each segment has two limit positions, one of which must overlap the opposite segment in the same axis: the electrical limit-up segment upper limit is set to the exact upper limit and the lower limit is set to the approximate down limit; the electrical limit-down segment lower limit is set to the exact lower limit and the upper limit is set to the approximate upper limit.

Condition	Limit (degrees)
Electrical limit-up (elevation segment A)	92
Electrical limit-down (elevation segment B)	-2
Electrical limit clockwise (azimuth segment A)	345
Electrical limit counterclockwise (azimuth segment B)	15
Servo limit-up (elevation segment C)	90.5
Servo limit-down (elevation segment D)	-0.5
Servo limit clockwise (azimuth segment C)	350
Servo limit counterclockwise (azimuth segment D)	10
Transmitter down (elevation segment E)	7.5 (r

2-32. Synchro Transmitter Circuit Analysis (fig. 9). Two 1-speed (1X) and one 36-speed (36X) sync transmitters, which are connected to a gear train in th data module, transmit antenna angular position in the form of synchro stator signals to synchro receivers in the following equipment: Analog antenna position indicators on antenna position and status panel 14A7 for remote angular display of antenna position; slave source equipment to provide antenna position indication, when operating in the slave mode; instrument servo assemblies in antenna control panel 14A8 to provide digital readout of antenna position.


B3
R1
R2
S1
S2
S3
B1
R1
R2
S1
S2
S3
B2
R1
R2
S3
S2
S1
ANTENNA POSITION (SYN TX) X1-S1
ANTENNA POSITION (SYN TX) X1-S2
ANTENNA POSITION (SYN TX) X1-S3
ANTENNA POSITION (SYN CX) X1-S1
ANTENNA POSITION (SYN CX) X1-S2
ANTENNA POSITION (SYN CX) X1-S3
ANTENNA POSITION (SYN CX) X36-S3
ANTENNA POSITION (SYN CX) X36-S2
ANTENNA POSITION (SYN CX) X36-S1
SYN REF R2
SYN REF R1
SYN REF R2
SYN REF R1
SYN REF R2
SYN REF R1
ANTENNA
POSITION
AND STATU
PANEL
14A7
S1
NO
C
A
NC
B
C
D
E
F
G
NOTE 1
ELECTRICAL LIMIT-UP/CW STATUS
ELECTRICAL LIMIT-UP/CW EXCITATION
ELECTRICAL LIMIT-DOWN/CCW STATUS
ELECTRICAL LIMIT-DOWN/CCW EXCITATION
SERVO LIMIT-UP/CW STATUS
SERVO LIMIT-UP/CW EXCITATION
SERVO LIMIT-DOWN/CCW STATUS
SERVO LIMIT-DOWN/CCW EXCITATION
REFLECTOR DOOR SWITCH/LOW ELEVATION CUTOFF
CONTROL-MONIT
C-9861/G OR
C-9854/G
(SYSTEM STATUS
LOGIC UNIT
15A5)
REFLECTOR DOOR SWITCH/LOW
ELEVATION CUTOFF INTERLOCK
REFLECTOR DOO
SWITCH
HTA-2A1S1

NOTES:
1. THIS CONTACT USED ONLY ON ELEVATION DATA MODULE HTA-6A6A1.
2. NON-STANDARD ABBREVIATIONS ARE: TX=TORQUE TRANSMITTER CX=CONTROL TRANSMITTER.

EL5895-915-34-TM

Figure 2-9. Azimuth/elevation data modules HTA-8A7A1 and HTA-6A6A1 (typical), schematic diagram.

SECTION IX. CIRCUIT ANALYSIS OF PERSONNEL AND EQUIPMENT SAFETY CONTROLS

2-33. General. Personnel and equipment safety controls incorporated in the servo and control equipment include an antenna safe interlock and a radio frequency cutoff interlock (fig. 2-10). The antenna safe interlock consists of four antenna safe switches, a breakaway electrical connector plug and a reflector door switch segment connected in series with the ANT. SAFE key switch on the antenna position and status panel. If the ANT. SAFE pushbutton on any antenna safe switch is operated, or if the cable breakaway electrical connector plug is pulled apart, or if the reflector door is opened, the antenna safe interlock is opened and move-ment of the antenna is halted by action of the major fault circuit. (Refer to paragraphs 2-3, 2-7, and 2-11.) The radio frequency cutoff interlock consists of a separate segment of the reflector door switch and a segment of the elevation data module limit switch (para 2-31). If either of these segments is opened, a reflector door switch/low elevation cutoff signal is output to system status logic unit 15A5, which turns off the transmitting equipment.

2-34. Antenna Safe Switch HTA-4A7,6A9,8A10,8A27. The antenna safe switch is an alternate action switch containing two pushbuttons labeled ANT. OPR. and ANT. SAFE. When the ANT. SAFE pushbutton is pressed, the switch is latched in the open position. When the ANT. OPR. pushbutton is pressed, the switch is released, closing the normally closed contacts and providing continuity to the antenna safe interlock circuit.

2-35. Breakaway Electrical Connector Plug HTA-P201. The breakaway electrical connector plug HTA-P201 is associated with the azimuth cable wrap and data module assembly HTA-8A7. One section of the connector is fastened to a stationary frame and the other section is fastened by a lanyard to the backshaft, which rotates in the azimuth axis with the antenna (fig. 1-7, sh 1). The lanyard pulls the two sections of the connector apart when ±240 degrees (from 180 degree stow position) rotation in the azimuth axis is exceeded. When the connector sections are pulled apart, an open circuit is presented to the antenna safe interlock circuit, halting antenna movement and preventing possible damage to the cable wrap assembly.

2-36. Reflector Door Switch HTA-2A1S1. The reflector door switch HTA-2A1S1 consists of a double-pole, single throw microswitch mounted adjacent to the antenna reflector door. Opening the antenna reflector door causes the reflector door switch contacts to open. One contact set is in series with the antenna safe switches and breakaway electrical connector plug HTA-P201 (para 2-34, 2-35); the other contact set is in series with the low elevation cutoff segment of the limit switch in the elevation data module. The second contact set provides an interlock with transmitter equipment. An open interlock disables the transmitter, thus removing rf radiation from the reflector.

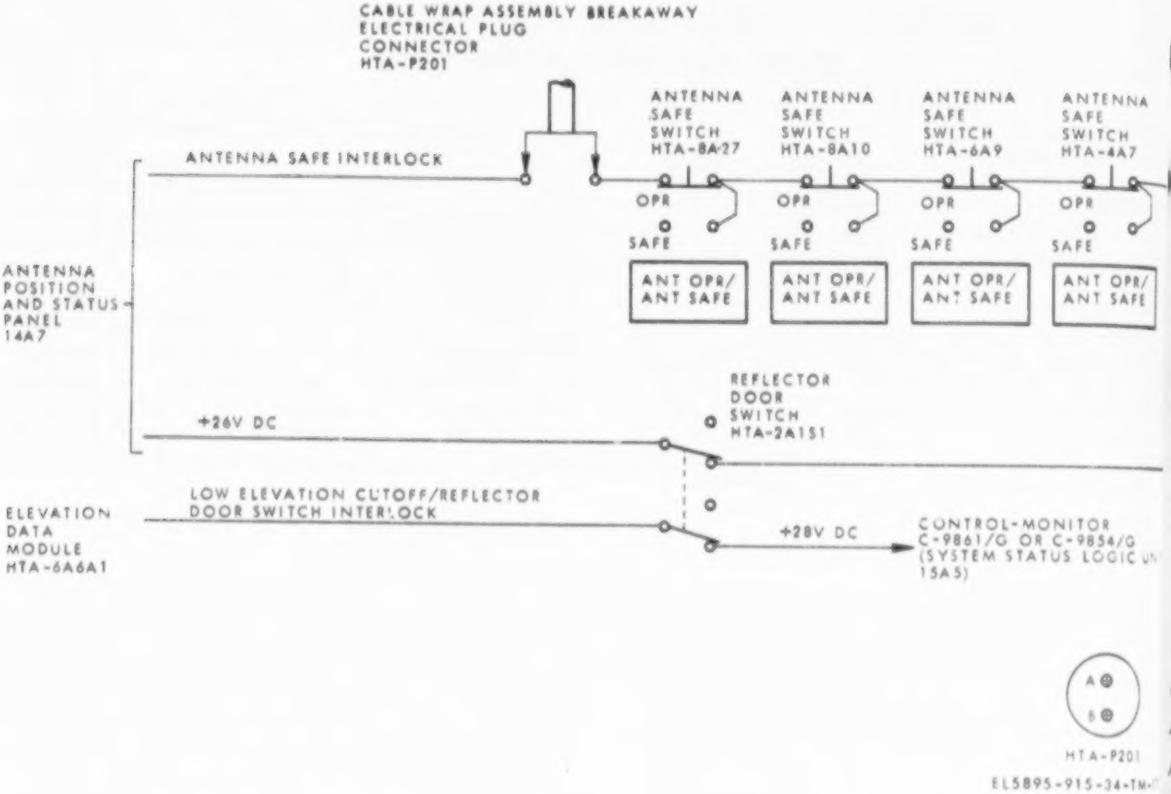

CABLE WRAP ASSEMBLY BREAKAWAY ELECTRICAL PLUG CONNECTOR HTA-P201
ANTENNA SAFE SWITCH HTA-8A27
ANTENNA SAFE SWITCH HTA-8A10
ANTENNA SAFE SWITCH HTA-6A9
ANTENNA SAFE SWITCH HTA-4A7
ANTENNA SAFE INTERLOCK
OPR
SAFE
ANT OPR/ ANT SAFE
ANTENNA POSITION AND STATUS PANEL 14A7
REFLECTOR DOOR SWITCH HTA-2A1S1
+26V DC
LOW ELEVATION CUTOFF/REFLECTOR DOOR SWITCH INTERLOCK
ELEVATION DATA MODULE HTA-6A6A1
+28V DC
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UN 15A5)
A
B
HTA-P201
EL5895-915-34-TM-

Figure 2-10. Antenna safety interlocks, simplified schematic diagram.

CHAPTER 3
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

SECTION I. GENERAL

3-1. Voltage and Resistance Measurements. The voltage and resistance measurements required to perform maintenance on servo and control equipment are decribed in the troubleshooting and performance test tables of this chapter. General procedures for making voltage and resistance measurements are provided in paragraph 3-3.

3-2. Tools and Test Equipment. Special tools and test equipment required for direct support maintenance are found in Repair Parts and Special Tools List, TM-11-5895-915-34P. Tools and test equipment required for maintenance described in this manual are listed in table 3-1.

Table 3-1 Tools and Test Equipment Required for Maintenance

Common name	Official nomenclature	Part/model no.	Qty	Manufacturer
AC Line Cord		17449-S	1	Belden
Adapter, AC, 3-Wire to 2-Wire		785-0419	1	Allied
Adapter, Banana Jack to Minigator Clip		3448	7	Pomona
Adapter, Banana Jack to Spade Lug		3744	3	Pomona
Adapter, Banana Jack to Size 20 Female Connector		3560	6	Pomona
Adapter, Binding Post to BNC Plug		1296	1	Pomona
Adapter, BNC Plug to Dual Binding Post		103-0035-00	2	Tektronix
Adapter, Single Banana Plug to Binding Post		2894	2	Pomona
Adapter, 14 or 16 Pin DIP Test Clip		3916	1	Pomona
Ammeter, Clamp On		749-2091001	1	Weston Instruments
Circuit Card Extender		SM-D-724007	1	Aeronutronic Ford
Generator, Function		3310B	1	Hewlett-Packard
Meter, Amp, Multirange, DC		931-2902001	1	Weston Instruments
Meter, Multifunction	Multimeter ME-482(P)/U	3450B	1	Hewlett-Packard
Milliammeter, Volt-Ohm (VOM)	Multimeter ME-450/U	260-6	1	Simpson
Oscilloscope, Dual-Trace	Oscilloscope, OS-261/U	475	1	Tektronix
ower Supply 0-80/0-40 V (Dual Output)	Power Supply, PP-7208/U	LPD-422A-FM	1	Lambda
robe, Oscilloscope, X1, X10		010-6063	2	Tektronix
heostat, Carbon Compression		82905	1	Central Scientific
est Lead, Banana Plug to Alligator Clip		1166-36-B	3	Pomona

Table 3-1 Tools and Test Equipment Required for Maintenance - Continued

Common name	Official nomenclature	Part/model no.	Qty	Manufacturer
		1166-36-R	2	Pomona
Test Lead, Banana Plug to Banana Plug		B-12(B)	1	Pomona
		B-12(R)	1	Pomona
Test Lead, Banana Plug to Banana Plug		B-48(B)	3	Pomona
		B-48(R)	3	Pomona
Test Lead, Banana Plug to Test Probe		1986-36-B	1	Pomona
		1986-36-R	1	Pomona
Test Lead, BNC Plug to Double Banana (44″)		11001A	1	Hewlett-Packard
Test Lead, Microgator Clip to Microgator Clip		1613-12	3	Pomona
Test Lead, Mini Test Clip to Mini Test Clip		3781-12	2	Pomona
Test Lead, Spade Lug to Banana Plug		1370-24-B	1	Pomona
		1370-24-R	1	Pomona
Test Lead, Spade Lug to Spade Lug		1743-36-B	2	Pomona
		1743-36-R	1	Pomona
Transformer, Variable		3PN2210	1	Staco

3-3. General Troubleshooting Instructions. This paragraph contains general procedures for voltage and resistance measurements as an aid for troubleshooting.

a. Voltage Measurements. In-circuit voltage measurements are useful in isolating a defective component or stage. Transistors can be checked easily by measuring the base-to-emitter bias. A transistor functioning as an amplifier is always forward biased. The base-to-emitter voltage of any turned-on silicon transistor is approximately 0.8 V; that of a germanium-type transistor approximately 0.4 V. A nonconducting transistor shows the full supply voltage at the collector. Methods for checking various types of components are described below.

(1) A quick method to check whether a forward-biased transistor functions as an amplifier is to remove the forward bias by shorting the emitter to base. The collector voltage in this case should rise to the approximate level of the supply voltage.

(2) Incorrect or absent supply voltage is usually caused by defective zener diodes. Check for the correct operating voltage across the zener diode. Refer to the appropriate schematic, troubleshooting procedure, or semiconductor reference books.

(3) Diodes are semiconductor devices with low resistance when forward-biased and high resista when reverse-biased. A large voltage drop across diode when forward-biased indicates a defective di

CAUTION

> Be careful when using a vtvm or oscilloscope to measure voltages within an operating module. The measuring instrument may upset the characteristics of some circuits, and false indications may be obtained. Refer to the appropriate module troubleshooting procedure for correct use of measuring instruments.

(4) Checking signal voltages within an oper module is, in most cases, an effective way of troubles ing a module. Signal voltage can be checked using a or oscilloscope.

(5) Peak-to-peak voltages of pulses and square waves can be measured with an oscilloscope.

(6) When measuring voltages, use the indicated test points when provided, rather than break the conform-al coating to get to connections.

b. In-Circuit Resistance Measurements. In-circuit checking of components should be performed where prac-tical. Most components can be checked for open or shorted conditions by using the appropriate multimeter. Use the Rx100 or Rx10K scale when there is a possibility of damaging the components. Loss of signal or supply voltage in a module may be caused by shorts, poor con-nections at plugs, broken wires, etc. Continuity checks using the multimeter will usually indicate the source of trouble. Use the appropriate schematic and interconnect-ing diagrams for guidance. In-circuit resistance checks will usually provide adequate indication of a faulty tran-sistor or diode. Suggested methods are given below.

(1) ***Npn transistors.*** With the red (+) lead of the multimeter on the base and the black (-) lead first on the collector and then on the emitter, the multimeter should normally indicate several hundred ohms (Rx100 scale). With reversed leads (black (-) on base) the resistance to the collector should be very high or infinite, while the resistance to the emitter should be several megohms (de-pending on the other components in the circuit).

(2) ***Pnp transistors.*** Reverse the connections and ndications in (1) above.

(3) ***Diodes.*** With diodes of type 1N914 or sim-lar, place the black (-) lead of the multimeter on the cathode, the red (+) lead on the anode; the meter should ndicate several hundred ohms. Reverse the leads and a ery high or infinite resistance should be obtained, de-ending on the circuit configuration.

c. Out-of-Circuit Resistance Measurements. Under ertain conditions, due to circuit configurations, it may not be possible to check a transistor or other component n the circuit; in this case the component must be discon- ected. Remove the suspected faulty component using the roper procedure (para 3-4b) and check as described in above. Only one end need be disconnected in order to heck diodes, varicaps, and some types of zener diodes. An additional test for an npn transistor consists of con- ecting the black (-) lead of the multimeter to the emitter nd the red (+) lead to the collector, which should give n infinite resistance indication. Next connect the red (+) ad to base and note the resistance reading; then short e base lead to collector to turn on the transistor; this ould produce a slightly lower reading on the meter. everse the multimeter leads when testing a pnp transis- r.

4. General Repair Instructions. This paragraph ovides general procedures for soldering and unsolder- g, component replacement, and connector repair.

a. Soldering and Unsoldering Procedures. To ensure gh reliability of electrical connections, certain proce-dures for hand soldering must be adhered to. A list of suggested procedures is given below.

(1) Use low wattage or temperature-controlled soldering irons and thermal (heat) sinks to prevent damage to heat-sensitive components such as semiconductors, glass bead capacitors, and insulating materials.

(2) Use appropriate soldering iron tips and solder quickly to avoid long periods of excessive heat during soldering and unsoldering on printed circuit boards (pcb) covered with conformal coating.

(3) Do not use transformer-type solder guns.

(4) Check the condition of soldering tips. Do not allow oxidation scale to accumulate on the tip. Maintain a bright, thin, but continuous tinned tip surface.

(5) Use a 60/40 type solder for tinning and general use. Use a low-melting point 63/37 type solder on printed circuit boards and when soldering heat-sensitive components.

(6) Remove excess flux, grease, or oil from the soldering points, using ethyl or isopropyl alcohol.

(7) Remove the conformal coating from the joint to be soldered with a broad-bladed knife or soldering iron.

(8) Use a heated copper braid to absorb the melted solder when unsoldering. Avoid using a solder sucker to remove the solder from printed circuit boards; this method may damage the joint and/or the printed circuit board.

(9) Avoid excessive temperatures to prevent unreliable joints and damage to parts. Use heat sinks, such as longnose pliers, to protect the components.

(10) Allow the solder to cool at room temperature. Do not use liquids to cool a soldered connection.

NOTE

Never use any abrasive cleaning agents on solder areas.

(11) Remove all visible flux and impurities from a cool solder joint, using a medium stiff material or synthetic bristle brush and approved solvent The soldered connection should be clean and have a smooth, undisturbed appearance.

(12) Use a wire brush to remove oxide, paint, and any other foreign matter from terminals before attaching wires and leads for soldering. Use a special type white eraser to remove gold plating from solder areas.

b. Component Replacement Techniques. General instrutions for replacement of chassis-mounted components are given below.

- (1) Tag electrical wires connected to the component for identification. Unsolder leads from the component by following approved unsoldering procedures (para 3-4a).
- (2) Remove the component.
- (3) Check and clean all replacement component leads prior to soldering, regardless of visual appearance.
- (4) Observe the polarity of replacement diodes, transistors, and electrolytic and tantalum capacitors.
- (5) Position the replacement component in the same place as the removal component. Do not mount components on top of other components. Position the replacement components so that any identification mark such as the part number, symbol, value, etc, is readily visible.
- (6) When components are mounted on standoff terminals, allow sufficient slack in the component leads to allow for vibration and temperature changes.
- (7) When wires are attached to terminals, sufficient insulation should be stripped off the wire to avoid contact between the insulation and the solder connection. Use proper stripping tools to avoid nicking, damaging, or breaking wires.
- (8) The ends of wires soldered to terminals should be wrapped around the terminals 1/2 to 3/4 turn (wires larger than 26 AWG) or 3/4 to 1-1/2 turns (wires smaller than 26 AWG). All portions of stranded wire and component leads which will be soldered should be properly tinned before attachment.
- (9) Use the correct type of insulated heat-shrinkable sleeving when replacing a circuit breaker. Use a thermogun for shrinking the sleeving.

c. Component Replacement Procedure. Component replacement procedures are as follows:

(1) ***Relays.*** Mark relay pin numbers on ind ual connecting wires with masking tape before remo the faulty relay. Replace relay, using approved solde techniques (para 3-4a).

(2) ***Small components.*** Small fixed capaci chokes, fixed resistors, and diodes are all replaced fol ing the general procedures described in subparagra above. Observe polarity on all types of diodes and elec lytic capacitors. Figure FO-1 illustrates color code m ings for small components.

(3) ***Potentiometers.*** Replace the compo following general procedures in subparagraph above; refer to an applicable paragraph for alignm procedures.

(4) ***Transformers.*** Transformers are readil placed. Identify all connecting wires before removing defective component to facilitate installation of the re cement transformer.

d. Multipin Connector Repair Procedures. Rep multipin connectors is performed as follows:

- (1) Tag and disconnect cable to faulty conne
- (2) Tag and unsolder wires to connector
- (3) Remove screws, washers, and nuts sec connector to panel.
- (4) Remove connector.
- (5) Clean off solder from all wires and ensur wires are properly stripped.
- (6) Fill pin cups on replacement connector small amount of solder.
- (7) Identify wires by tag and insert and s wire ends into pin cups.
- (8) Allow solder to cool, pull wire to ensure it is solidly attached, then slide insu sleeve over solder connection so that sleev snugly against connector.
- (9) Install connector on panel and secure to with screws, washers, and nuts.
- (10) Identify cable by tag and connect to con tor.

SECTION II. TROUBLESHOOTING OF SERVO AND CONTROL EQUIPMENT GROUP

3-5. General. This section provides a group level troubleshooting procedure for servo and control equipment. The procedure will assist in isolating a malfunction to the specific equipment unit. When a unit has been designated as faulty, a reference to the troubleshooting or maintenance section for that unit is included in the procedure.

3-6. Test Equipment and Materials Test equip and materials required for troubleshooting the serv control equipment group is a 260-6 volt milliammeter (vom) and a SM-D-724007 circuit extender.

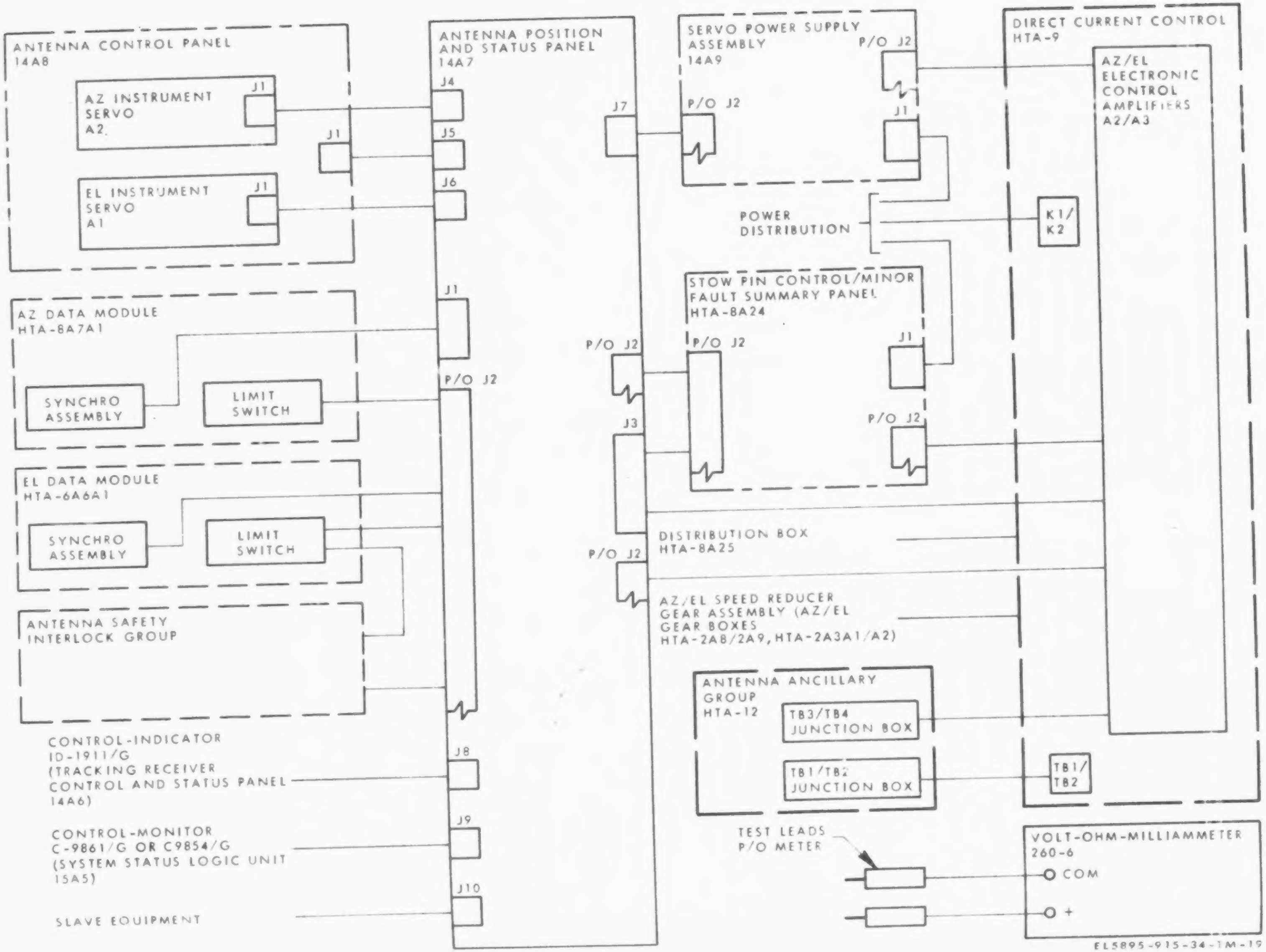
NOTE

The circuit card extender supplied with the tools requires removal of the guides to permit engagement of the antenna position and status panel card connectors.

3-7. Test Connections and Conditions. The group level troubleshooting procedure is performed with all servo and control equipment connected in an operational configuration and with the necessary interfaces connected and operational. (See figure FO-31.) For troubleshooting criteria, it is assumed that all input power and signals are available. Test points required for isolating isolating certain faults are specified on figure FO-32 and on figure 3-1.

3-8. Initial Control Settings. Verify that all servo and control equipment circuit breakers and switches are set for normal operation as specified in TM11-5895-898-12 or TM11-5895-899-12 for equipment turnon.

3-9. Troubleshooting Procedure (fig. FO-32). A true-false, road-map type drawing is provided in figure FO-32 to isolate selected faults to servo and control equipment units. Schematic/logic diagrams (figure FO-6 through FO-30) are required for aid in performing the group isolation procedures. Refer to the list of illustrations at the front of this manual for references. When a particular unit is indicated as faulty, proceed directly to the referenced section for further troubleshooting.


ANTENNA CONTROL PANEL
14A8
AZ INSTRUMENT
SERVO
A2
J1
J1
EL INSTRUMENT
SERVO
A1
J1
AZ DATA MODULE
HTA-8A7A1
SYNCHRO
ASSEMBLY
LIMIT
SWITCH
EL DATA MODULE
HTA-6A6A1
SYNCHRO
ASSEMBLY
LIMIT
SWITCH
ANTENNA SAFETY
INTERLOCK GROUP
CONTROL-INDICATOR
ID-1911/G
(TRACKING RECEIVER
CONTROL AND STATUS PANEL
14A6)
CONTROL-MONITOR
C-9861/G OR C9854/G
(SYSTEM STATUS LOGIC UNIT
15A5)
SLAVE EQUIPMENT
ANTENNA POSITION
AND STATUS PANEL
14A7
J4
J5
J6
J1
P/O J2
J8
J9
J10
J7
P/O J2
J3
P/O J2
SERVO POWER SUPPLY
ASSEMBLY
14A9
P/O J2
P/O J2
J1
POWER
DISTRIBUTION
STOW PIN CONTROL/MINOR
FAULT SUMMARY PANEL
HTA-8A24
P/O J2
J1
P/O J2
DISTRIBUTION BOX
HTA-8A25
AZ/EL SPEED REDUCER
GEAR ASSEMBLY (AZ/EL
GEAR BOXES
HTA-2A8/2A9, HTA-2A3A1/A2)
ANTENNA ANCILLARY
GROUP
HTA-12
TB3/TB4
JUNCTION BOX
TB1/TB2
JUNCTION BOX
TEST LEADS
P/O METER
DIRECT CURRENT CONTROL
HTA-9
AZ/EL
ELECTRONIC
CONTROL
AMPLIFIERS
A2/A3
K1/
K2
TB1/
TB2
VOLT-OHM-MILLIAMMETER
260-6
COM
+
EL5895-915-34-TM-19

SECTION III. TROUBLESHOOTING OF ANTENNA CONTROL PANEL 14A8

3-10. General. This section contains preliminary procedures and troubleshooting procedures necessary for fault localization to a malfunctioning assembly, subassembly, or module of antenna control panel 14A8 after referral by organizational maintenance. This section also includes the procedures necessary for bench-testing instrument servo assembly 14A8A1 or 14A8A2. Preliminary procedures consist of obtaining the listed test equipment, making the prescribed test connections, and initially setting equipment controls as specified. These settings and all subsequent settings given in the troubleshooting procedure must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement or repair of a malfunctioning assembly or component, refer to section XI in this chapter for replacement or repair procedure. When a troubleshooting procedure specifies replacement or repair of an assembly or component by higher level maintenance, notify appropriate personnel.

3-11. Test Equipment and Materials. The only test equipment required for troubleshooting the antenna control panel is a 260-6 vom.

3-12. Test Connections and Conditions (fig. 3-2). Troubleshooting of antenna control panel 14A8 is performed with the chassis connected in the operational configuration and extended out from the control console to provide access to test points and components. Test points are shown in figure 3-2. Test connections are specified in the troubleshooting table. Extend the antenna control panel chassis to the maintenance position by loosening the four captive screws and pulling the chassis out to the stops.

3-13. Initial Control Settings. The antenna control panel controls should be set for online system operation and should be changed only as necessary for fault isolation. Set vom function switch to DC and range switch to 10 V.

3-14. Troubleshooting Procedure. After completing the preliminary procedures, perform the necessary steps in table 3-2 as specified by symptom/probable cause listing below. The antenna control panel 14A8 schematic (fig. FO-6) will assist in performing the troubleshooting procedures. See figure 3-3 for parts location. When the faulty component has been located and replaced as described in section XI, verify that the fault has been corrected by either performance testing the entire antenna control panel as described in section XIX or repeating the step in the toubleshooting table where the trouble was found. After successful completion of either the performance test or the step(s) in the troubleshooting table, the antenna control panel can be returned to service.

Symptom	Probable cause
Unable to advance to manual mode from standby mode.	MANUAL MODE indicator switch S3 faulty. Refer to step 1.
Unable to advance to aquisition mode from manual mode.	ACQUISITION MODE indicator switch S1 faulty. Refer to step 2.
Unable to advance to slave mode during slave operation from manual mode.	SLAVE MODE indicator switch S2 faulty. Refer to step 3.
Unable to select standby mode from any other mode.	STANDBY MODE indicator switch S4 faulty. Refer to step 4.
ELEVATION antenna position indicator does not follow antenna movement about elevation axis in the autotrack or manual (slew control on panel) mode but servo equipment operates normally in manual (handcrank control on panel) mode.	Elevation instrument servo assembly A1 faulty. Refer to step 5.
Azimuth antenna position indicator does not follow antenna movement about azimuth axis in autotrack or manual (slew) mode but servo equipment operates normally in manual (handcrank) mode.	Azimuth instrument servo assembly A2 faulty. Refer to step 5.
Antenna may be positioned in the elevation axis but not the azimuth axis, with respective handcrank on antenna control panel; corresponding SLEW control operation is normal.	Azimuth instrument servo assembly A2 faulty. Refer to step 5.
Antenna may be positioned in azimuth axis but not elevation axis, with respective handcrank on antenna control panel; corresponding SLEW control operation is normal.	Elevation instrument servo assembly A1 faulty. Refer to step 5.
Antenna may be positioned with EL	Azimuth slew assembly

Symptom	Probable cause	Symptom	Probable cause
SLEW control but not with AZ SLEW control; corresponding handcrank operation is normal.	R2 faulty. Refer to step 6.	Antenna may be positioned with AZ SLEW control but not with EL SLEW control; corresponding handcrank operation is normal.	Elevation slew assembly R1 faulty. Refer to step 6.

Table 3-2 Antenna Control Panel 14A8 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	MANUAL MODE indicator switch S3	MANUAL indicator switch is pressed.	Connect vom (+) lead to S3-C and (-) lead to S3-NO. NOTE Switch has four segments, only one of which is used. Top contact of each segment is C; bottom contact is NO.	0 ±0.5 V dc	If indication is abnormal, replace S3 if normal, refer to antenna position and status panel troubleshooting procedures (section IV).
2	ACQUISITION MODE indicator switch S1	ACQUISITION indicator switch is pressed.	Connect vom to S1-C (-) and S1-NO (+).	0 ±0.5 V dc	If indication is abnormal, replace S1 if normal, refer to antenna position and status panel troubleshooting procedures (section IV).
3	SLAVE MODE indicator switch S2	SLAVE indicator switch is pressed.	Connect vom to S2-C (-) and S2-NO (+).	0 ±0.5 V dc	If indication is abnormal, replace S2 if normal, refer to antenna position and status panel troubleshooting procedures (section IV).
4	STANDBY MODE indicator switch S4	STANDBY indicator switch is pressed.	Connect vom to S4-C (-) and S4-NO (+).	0 ±0.5 V dc	If indication is abnormal, replace S4 if normal, refer to antenna position and status panel troubleshooting procedures (section IV).
5	Azimuth instrument servo A2 or elevation instrument servo assembly A1	Note readouts on AZIMUTH and ELEVATION position indicators, switch instrument servo assembly input/output cables to opposite connectors.	None	AZIMUTH ELEVATION position indicator readouts reverse.	If indications reverse, reconnect cable in normal configurations and refer to antenna position and status panel troubleshooting procedures (section IV). If indications do not reverse, troubleshoot the defective instrument servo assembly in accordance with paragraph 3-15.
6	Azimuth slew assembly R2 or elevation slew assembly R1	a. Servo and control equipment are in manual mode.	a. Connect vom (+) lead to R1S1NO (EL) or R2S1-NO (AZ) and (-) lead to R1S1-C (R2S1-C).	a. +5 ±0.5 V dc	a. If indication is abnormal, check for +5 V between R1S1-NO (R2S1-NC) and chassis ground. V is obtained, replace defective slew assembly; if not, troubleshoot antenna position and status panel (section IV).
		b. Rotate AZ (EL) SLEW	b. Same as substep a above	b. 0 ±0.5 V dc	

Table 3-2 Antenna Control Panel 14A8 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
		EW control off neutral position in both directions.			F b. If indication is abnormal, replace defective slew assembly; if normal, disconnect meter leads and perform substep c.
		c. Rotate AZ (EL) SLEW control to maximum CW.	c. Connect vom (+) lead to slew assembly R1A(R2A)-S contact and (-) lead to CT contact.	c. -15 to -13 V dc	c. If reading is abnormal, replace defective slew assembly; if normal, perform substep d.
		d. SLEW control to maximum CCW.	d. step c	d. +13 to +15 V dc	d. If indication is abnormal, replace defective slew assembly; if normal, Additional checks and remarks and status panel (section IV) for further troubleshooting procedures.

3-15. Instrument Servo Assembly Troubleshooting. This paragraph provides the preliminary procedures and troubleshooting procedures for elevation or azimuth instrument servo assembly A1 or A2 contained in antenna control panel 14A8.

a. Test Equipment and Materials. Table 3-3 contains a complete list of test equipment and materials required to troubleshoot an instrument servo assembly.

Table 3-3 Test Equipment Required for Instrument Servo Assembly 14A8A1, A8A2 Troubleshooting and Performance Test Procedures

Common neme	Part/model no.	Qty	Manufacturer
C Line Cord	17449-S	1	Belden
dapter, Banana Jack to Size 20 Female Connector	3560	6	Pomona
dapter, Binding Post to BNC Plug	1296	1	Pomona
dapter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
dapter, Single Banana Plug to Binding Post	2894	2	Pomona
enerator, Function	3310B	1	Hewlett-Packard
leter, Multifunction	3450B OPT001, 002	1	Hewlett-Packard
illiammeter, Volt-Ohm- (VOM)	260-6	1	Simpson
wer Supply, 0-80/0-40V	LPD-422A-FM	1	Lambda
st Lead, Banana Plug to Alligator Clip	1166-36-B	2	Pomona
	1166-36-R	2	Pomona
st Lead, Banana Plug to Banana Plug	B-12(B)	1	Pomona

Table 3-3 Test Equipment Required for Instrument Servo Assembly 14A8A1, A8A2 Troubleshooting and Performance Test Procedures - Continued

Common name	Part/model no.	Qty	Manufacturer
Test Lead, Banana Plug to Banana Plug	B-12(R)	1	Pomona
	B-48(B)	3	Pomona
	B-48(R)	3	Pomona

b. Test Connections and Conditions (fig. 3-4). Troubleshooting of an instrument servo assembly is performed in a bench-test setup. Remove the instrument servo assembly from antenna control panel 14A8 (section XI). Remove the cover from the instrument servo assembly by removing four screws at the rear of the unit and sliding the cover from the chassis. Arrange the instrument servo assembly and test equipment as shown in figure 3-4 but do not make any connections to test points.

c. Initial Control Settings. Initial control settings for the troubleshooting procedure are as follows.

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	AC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Vom	
Function	+DC
Range	Rx1
Dual-output power supply	
POWER	OFF
Function generator	
RANGE	10
Frequency Dial	6
DC OFFSET	0
FUNCTION	SINE
LINE	ON
OUTPUT LEVEL	Max. ccw

d. Troubleshooting Procedure. Table 3-4 prov step-by-step troubleshooting procedures to isolate a function to a faulty part. Perform the procedures in sequence given until an abnormal indication is fou Replace faulty parts as described in section XI and the instrument servo assembly as described in sec XXI. Use the electrical schematic diagram (fig. FO- an aid to locating the trouble cause and use figure 3- parts location.

Table 3-4 Instrument Servo Assembly 14A8A1,A8A2 Troubleshooting Procedure

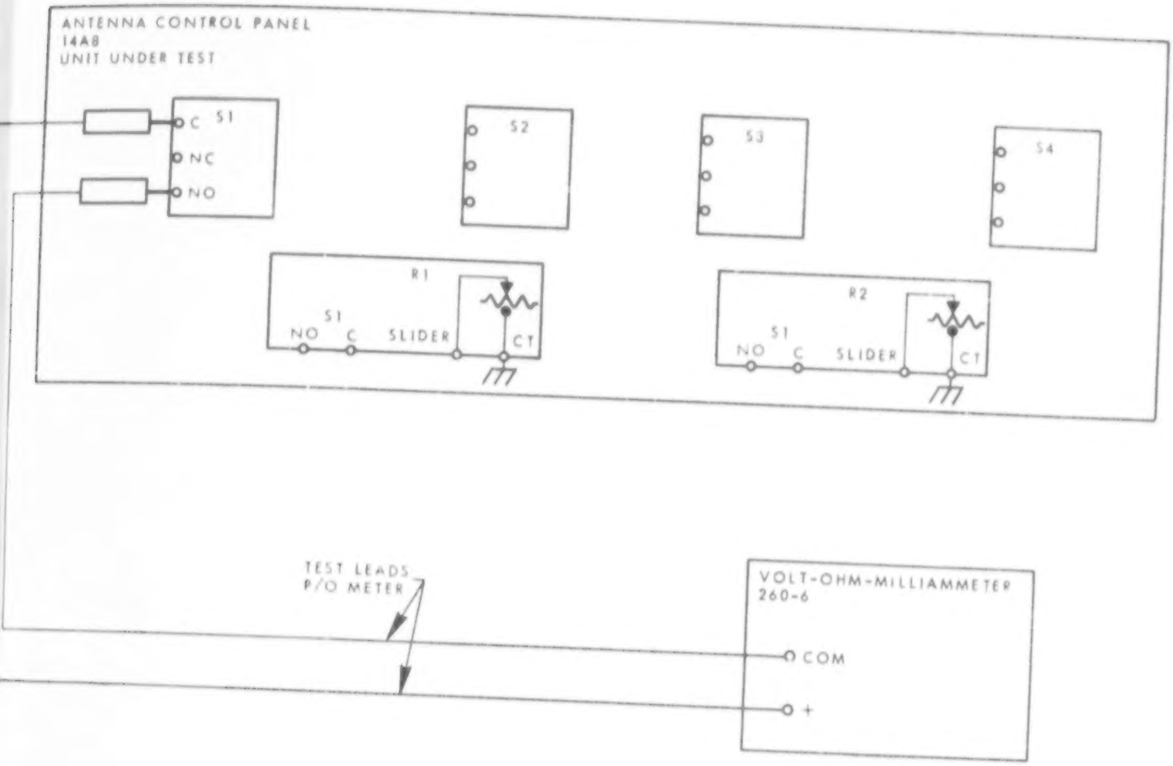
Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Circuit resistances for isolating faults to the following components:	Range switch on vom is set as indicated below.	Connect vom test leads to J1 pins listed below.	As indicated below	Perform the checks or operations sp fied below for any abnormal indi tion. Refer to section XI for rep and replacement details.
	a. Filter FL1, transformers T1 and T2 primary, and	a. Rx1	a. A - B	a. 40 ohms (max)	a. If resistance is infinite, replace F resistance is between 600 and 70 ohms, replace T2; if resistance

Table 3-4 Instrument Servo Assembly 14A8A1,A8A2 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	motor B1				ohms, check for short across following components and replace as necessary: T1/T2 primary, B1 pins W and Y.
	b. Synchros B2 and B3	b. Rx 100	b. W - D D - E E - W Y - F F - G G - Y S - R	b. 1500 ohms 1500 ohms 1500 ohms 1500 ohms 1500 ohms 1500 ohms 750 ±75 ohms	b. The actual resistance may vary from 1500 ohms, however all three resistances for either synchro must be the same (within 75 ohms). If not, refer to general support maintenance (chapter 4) for replacement procedures for faulty synchro. If indication is abnormal, refer to general support maintenance for replace ment of faulty synchro. If indication is normal, check for 750 ±75 ohms between R1/R2 junction and CR3 cathode. If this indication is abnormal, refer to general maintenance for replacement of B2.
	c. Diode CR1	c. Rx1	c. a - b(com) b - a(com)	c. 15 ohms (max) 125 ohms (max)	c. If resistance is near 0 or 100 ohms, replace diode CR1. If resistance is near 0, replace diode CR1.
	d. Resistor R8	d. R x 10,000	d. j - f	d. 51 kilohms (nominal)	d. Check color code on R8. If measured resistance is not as indicated by color code (including tolerances), replace R8 with one of the same value as color code indication.
2	Transformer T2	One lead of transformer primary input leads (pins 4 and 5) is disconnected.	Using vom test leads, connect vom to T2-4 and T2-5.	12 kilohms (max)	If indication is abnormal, replace T2; if normal, resolder connection to pin 4 (5).
3	Motor B1 reference winding	Yellow lead of motor reference input is disconnected at T1-2.	Connect vom to B1 reference input.	750 ohms (max)	If indication is abnormal, submit assembly to general support maintenance for replacement of B1. If normal, resolder lead to T1.
	Relay K1, clutch L1, and counter	a. None	a. Connect vom to K1-1 and K1-3.	a. Less than 1 ohm	If indication is abnormal, replace K1; if normal, perform substep b.
		b. After making specified test connections, set power supply power switch to ON and adjust power supply for 24 V dc output.	b. Connect vom to K1-5 and K1-3, dual-output power supply, to J1-b(+) and a(rtn).	b. Clutch audibly engages, vom indicates less than 1 ohm.	b. If clutch does not engage, submit L1 to general support maintenance for repair. If vom indication is abnormal, replace K1. If both indications are normal, perform substep c.
		c. Note counter indication, rotate counter shaft 1 turn (360 degrees) and again note counter indication.	c. Same as substep b above	c. indicates 1 ±0.02 degree change.	c. If indication is abnormal, replace counter. If normal, disconnect vom.
	Transformer T1 secondary.	Set vom function switch to AC and range switch to 50 V.	Connect 120 V ac to J1A and B with ac line cord 17449 and adapters 2894 and 3560; connect vom to T1-3 and T1-4.	32 ±3.2 V ac	If indication is abnormal, replace T1. If normal, disconnect vom.

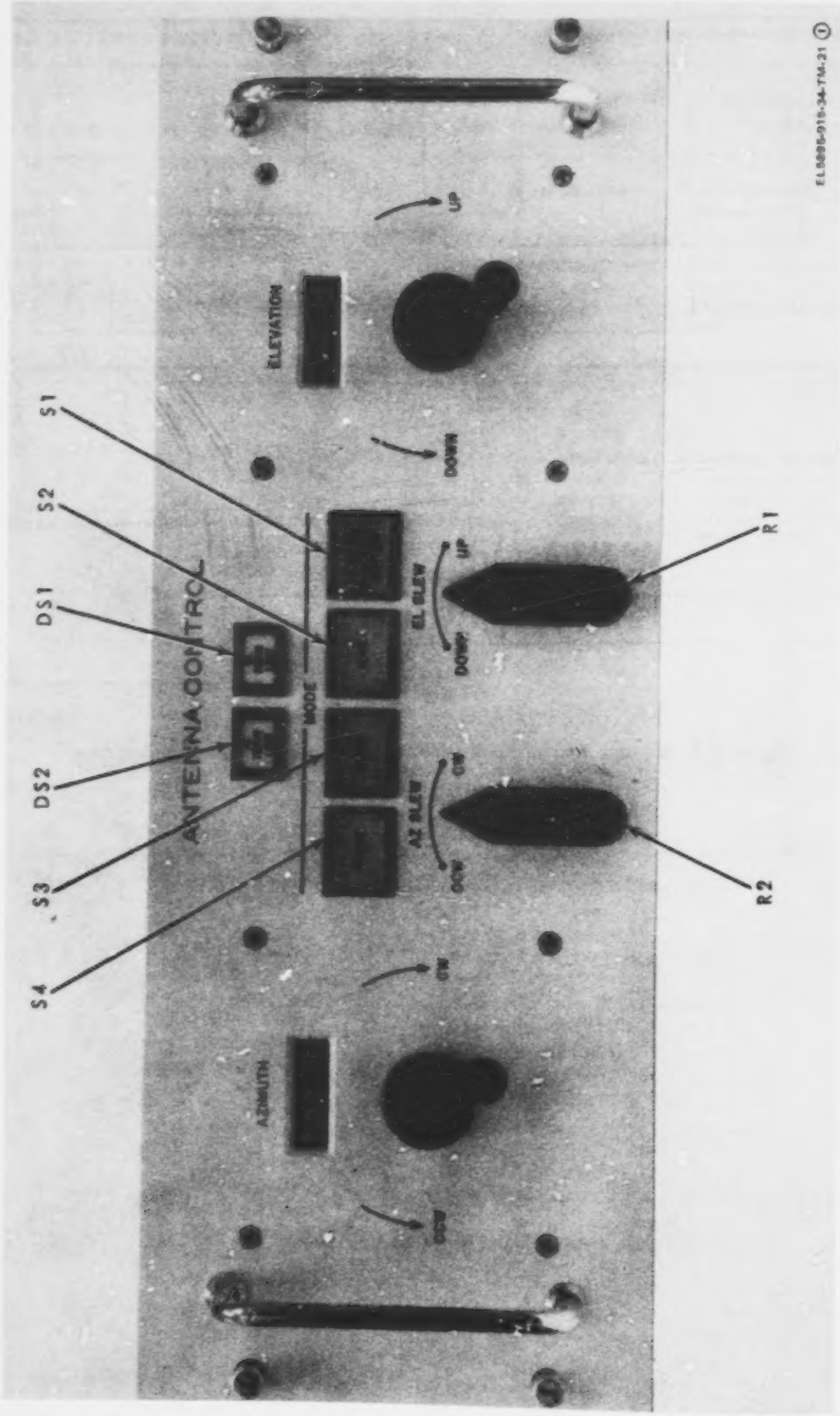
Table 3-4 Instrument Servo Assembly 14A8A1,A8A2 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
6	Power supply PS1	Set vom function switch to +DC and range switch to 50 V.	Same as step 5 except connect vom to PS1-3 (com) and PS1-2.	42 ±4.2 V dc	If indication is abnormal, replace PS
7	Amplifier AR1 and motor B1		a. Connect function generator to AR1 at J2A and J2B, with 1166-36 test leads and 1296 adapter (momentary only); connect multifunction meter x terminals to adapter 1296 on function generator with B-48 test leads.	a. Counter starts to count.	a. Adjust function generator outpu control for 1 V rms indication on tifunction meter, then perform below.
			b. Disconnect multifunction meter from function generator and connect vom leads to AR1J2-E and F with 1166-36 test leads. Connect function generator to AR1 at J2A and J2B.	b. 40 ±4 V rms, counter up counts then reverses.	b. If voltage indication is normal b counter did not move, submit ase bly to general support maintena for replacement of B1, if voltage cation is abnormal, replace AR
8			Disconnect test equipment, slide cover on chassis, secure with four screws and install instrument servo assembly in antenna control panel (section XI).		


ANTENNA CONTROL PANEL
14A8
UNIT UNDER TEST
S1
C
NC
NO
S2
S3
S4
R1
S1
NO
C
SLIDER
CT
R2
S1
NO
C
SLIDER
CT
TEST LEADS
P/O METER
VOLT-OHM-MILLIAMMETER
260-6
COM
+

EL5895-915-34-TM-20

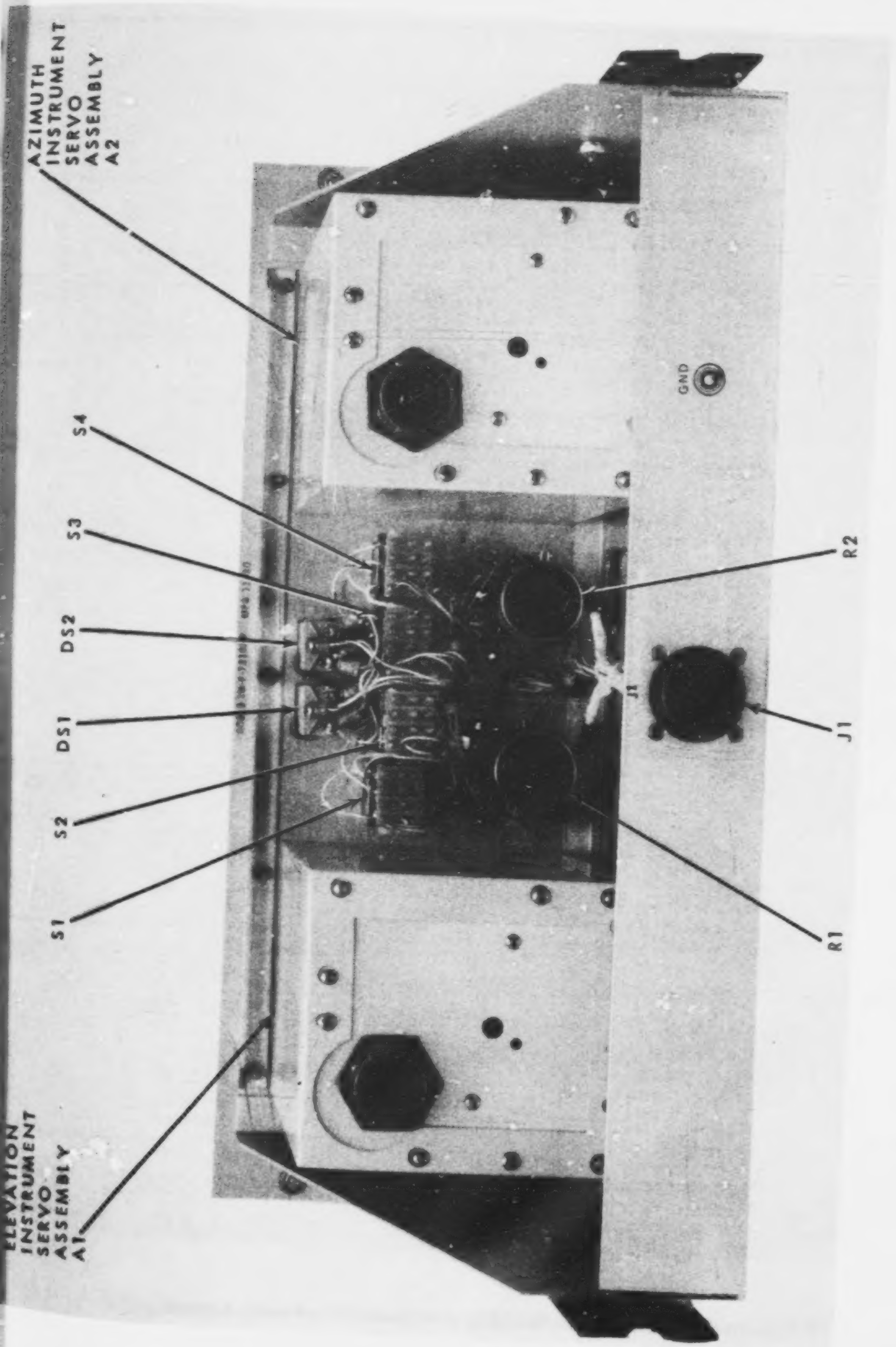
Figure 3-2. Antenna control panel 14A8, troubleshooting, test setup diagram.


S1
S2
DS1
DS2
S3
S4
R1
R2
ANTENNA CONTROL
ELEVATION
UP
DOWN
MODE
EL SLEW
UP
DOWN
AZ SLEW
CW
CCW
AZIMUTH
CW
CCW

EL5895-915-34-TM-21 ①

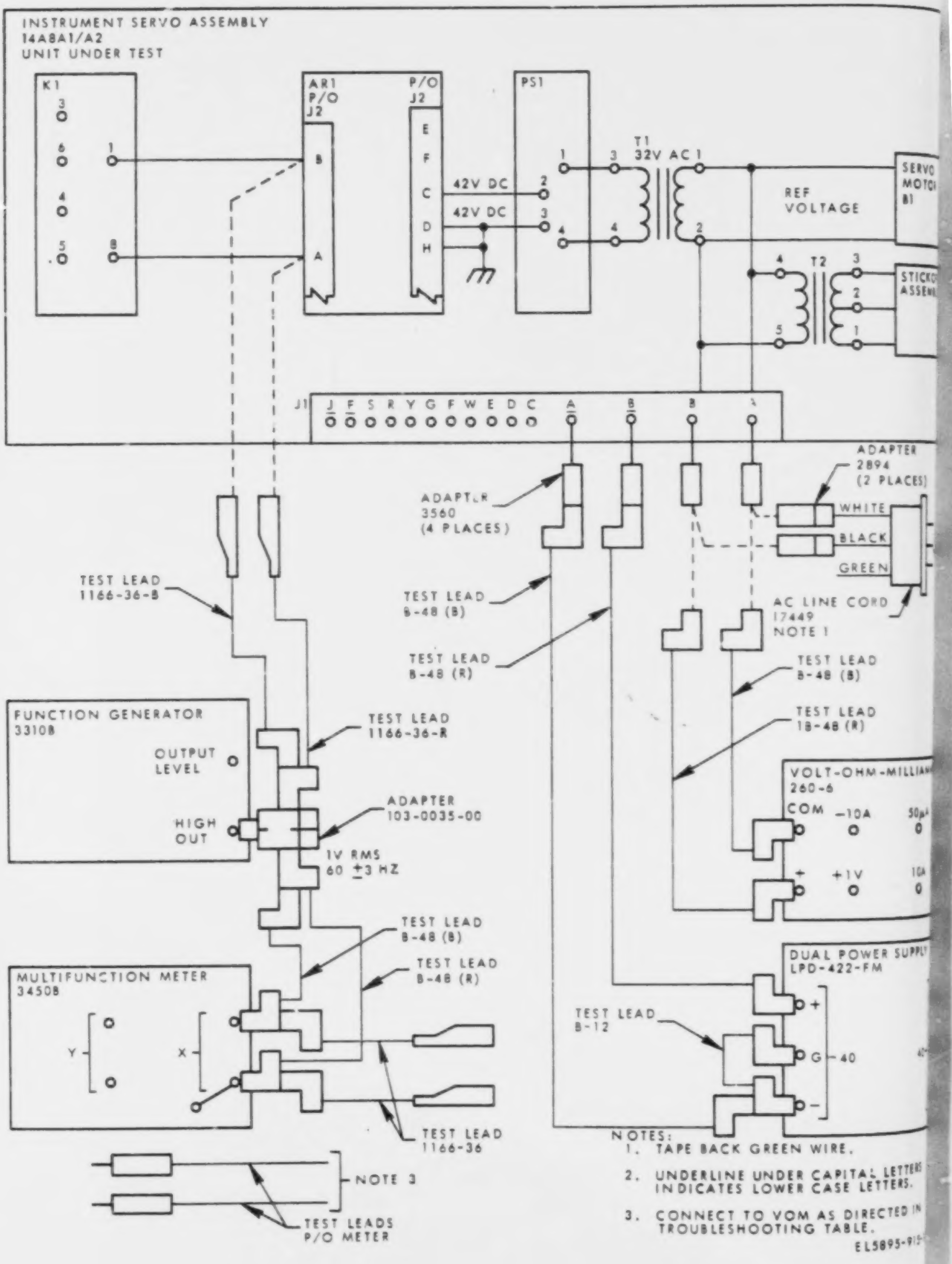
Figure 3-3. Antenna control panel 14A8, parts location (sheet 1 of 2).

best copy available
pages tightly bound


AZIMUTH INSTRUMENT SERVO ASSEMBLY A2
S4
S3
DS2
DS1
S2
S1
ELEVATION INSTRUMENT SERVO ASSEMBLY A1
GND
J1
R2
J1
R1

EL5895-915-34-TM-21 ②

Figure 3-3. Antenna control panel 14A8, parts location (sheet 2 of 2).


INSTRUMENT SERVO ASSEMBLY
14A8A1/A2
UNIT UNDER TEST
K1
3
6
4
5
1
8
AR1
P/O
J2
B
A
P/O
J2
E
F
C
D
H
42V DC
42V DC
PS1
1
2
3
4
T1
32V AC
1
3
4
2
REF
VOLTAGE
SERVO
MOTO
B1
T2
4
5
3
2
1
STICK
ASSE
J1
J F S R Y G F W E D C A B B A
ADAPTER
2894
(2 PLACES)
WHITE
BLACK
GREEN
ADAPTER
3560
(4 PLACES)
TEST LEAD
1166-36-B
TEST LEAD
B-48 (B)
TEST LEAD
B-48 (R)
AC LINE CORD
17449
NOTE 1
TEST LEAD
B-48 (B)
TEST LEAD
1B-48 (R)
FUNCTION GENERATOR
3310B
OUTPUT
LEVEL
HIGH
OUT
TEST LEAD
1166-36-R
ADAPTER
103-0035-00
1V RMS
60 ±3 HZ
VOLT-OHM-MILLIA
260-6
COM
-10A
50μ
+
+1V
10A
TEST LEAD
B-48 (B)
TEST LEAD
B-48 (R)
MULTIFUNCTION METER
3450B
Y
X
DUAL POWER SUPPL
LPD-422-FM
+
G
-
40
TEST LEAD
B-12
TEST LEAD
1166-36
NOTE 3
TEST LEADS
P/O METER
EL5895-915

NOTES:
1. TAPE BACK GREEN WIRE.
2. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.
3. CONNECT TO VOM AS DIRECTED IN TROUBLESHOOTING TABLE.

Figure 3-4. Instrument servo assembly 14A8A1,A8A2, test setup diagram.

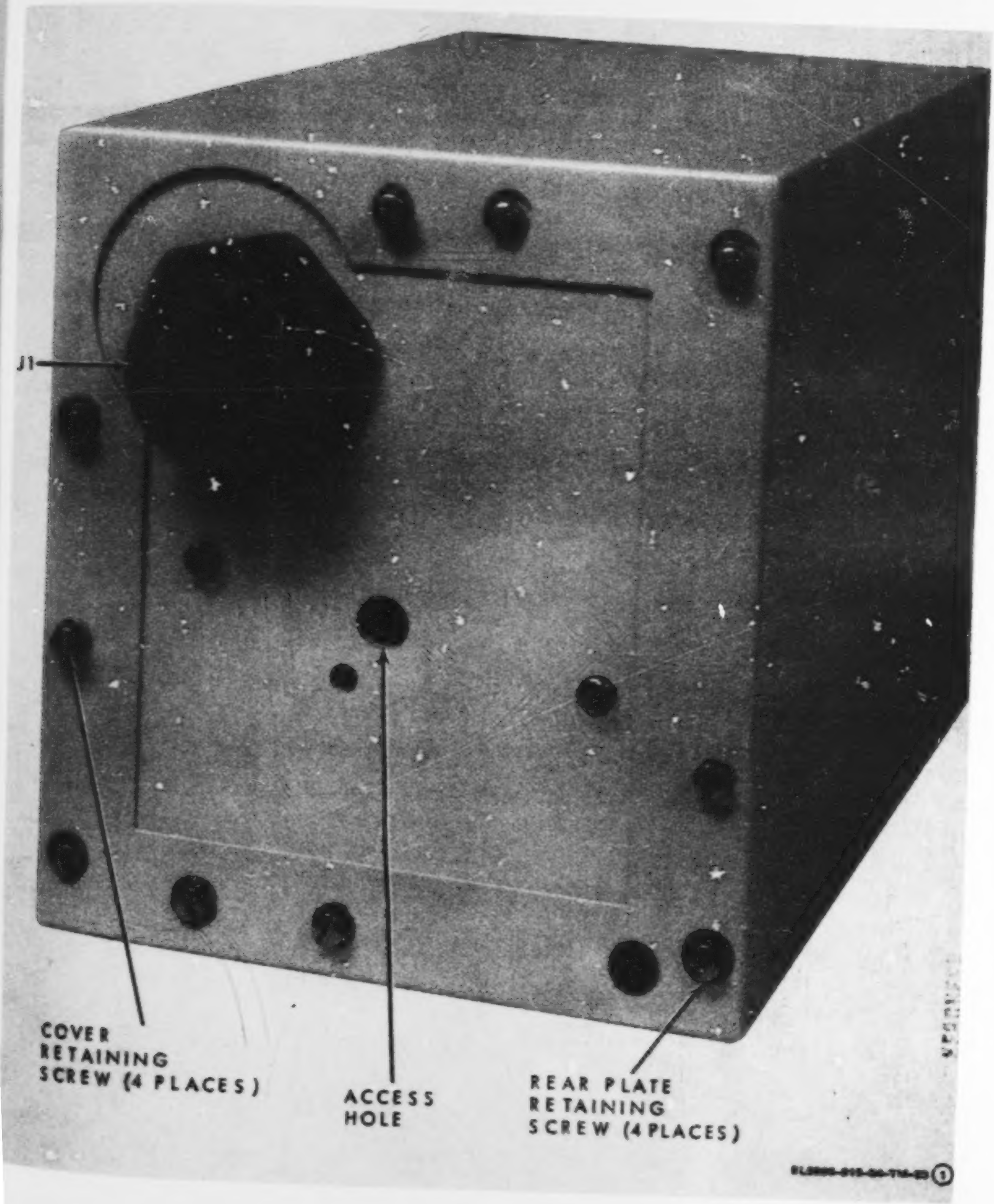

J1
COVER RETAINING SCREW (4 PLACES)
ACCESS HOLE
REAR PLATE RETAINING SCREW (4 PLACES)
EL5895-915-00-TM-23 ①

Figure 3-5. Instrument servo assembly 14A8A1, A8A2, parts location (sheet 1 of 5).

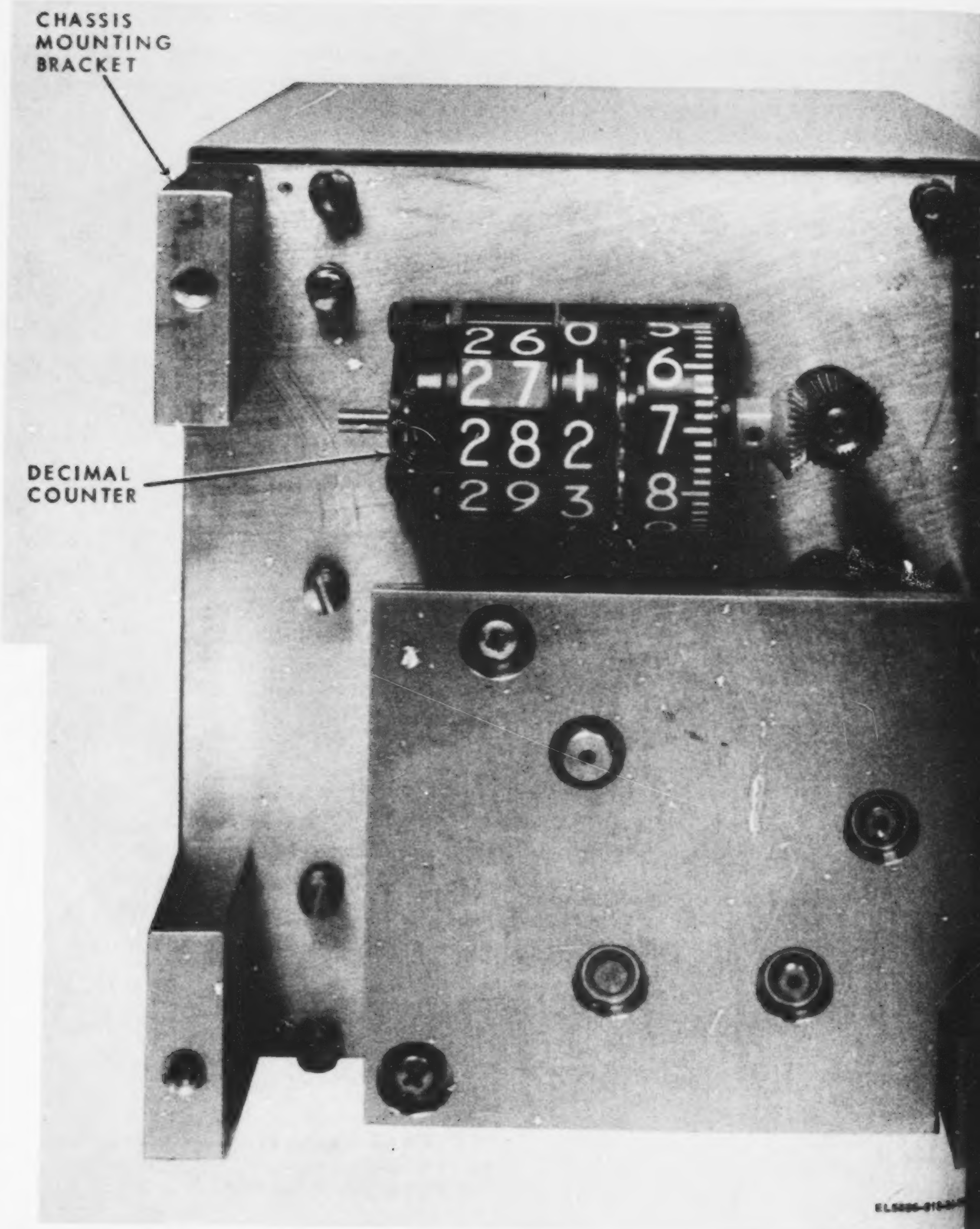
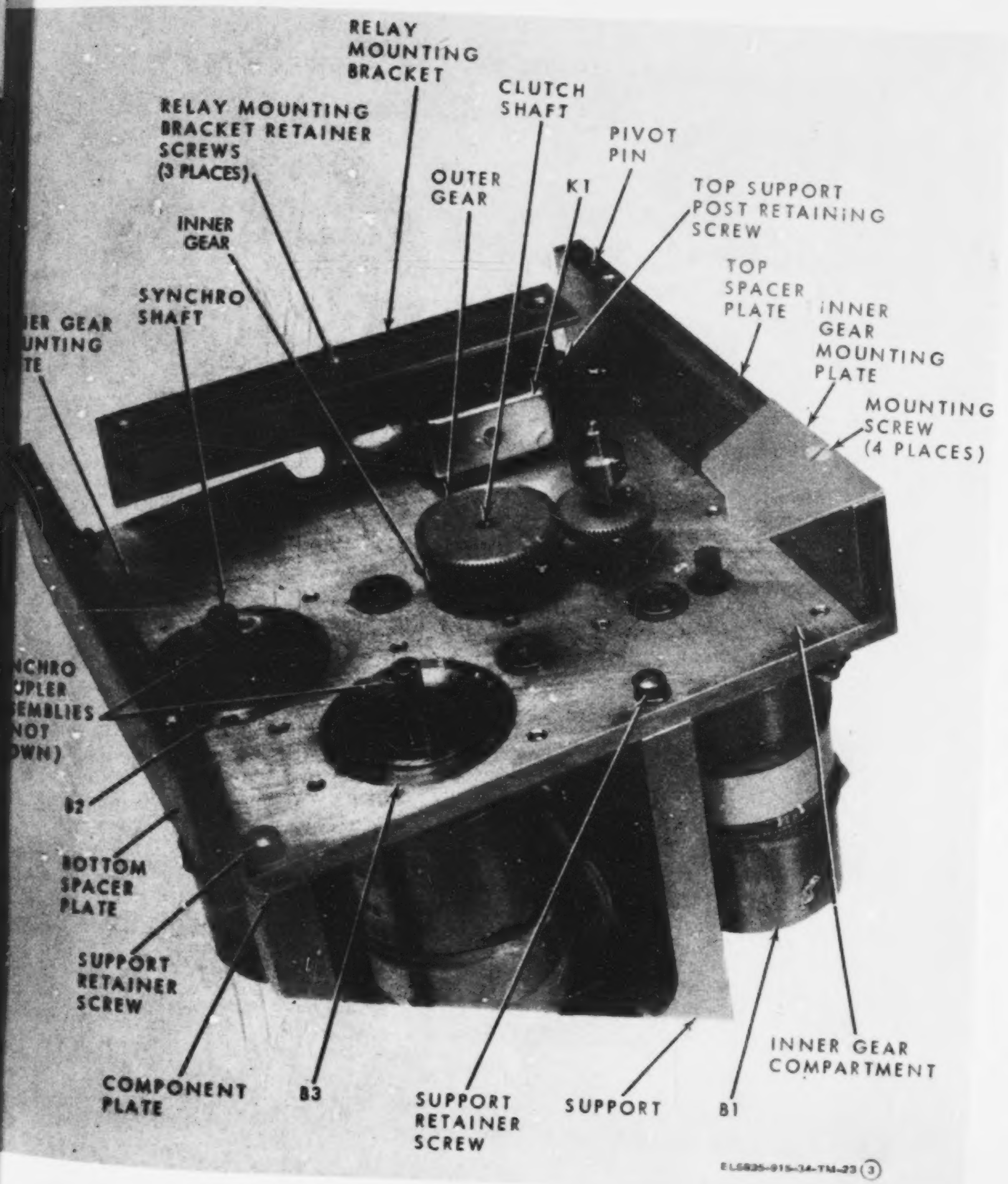

CHASSIS MOUNTING BRACKET
DECIMAL COUNTER

Figure 3-5. Instrument servo assembly 14A8A1, A8A2, parts location (sheet 2 of 5).


RELAY MOUNTING BRACKET
RELAY MOUNTING BRACKET RETAINER SCREWS (3 PLACES)
CLUTCH SHAFT
PIVOT PIN
OUTER GEAR
K1
TOP SUPPORT POST RETAINING SCREW
INNER GEAR
TOP SPACER PLATE
INNER GEAR MOUNTING PLATE
SYNCHRO SHAFT
IER GEAR
UNTING
TE
MOUNTING SCREW (4 PLACES)
NCHRO
UPLER
SEMBLIES
NOT
WN)
B2
BOTTOM SPACER PLATE
SUPPORT RETAINER SCREW
INNER GEAR COMPARTMENT
COMPONENT PLATE
B3
SUPPORT RETAINER SCREW
SUPPORT
B1

EL5895-915-34-TM-23 ③

Figure 3-5. Instrument servo assembly 14A8A1, A8A2, parts location (sheet 3 of 5).

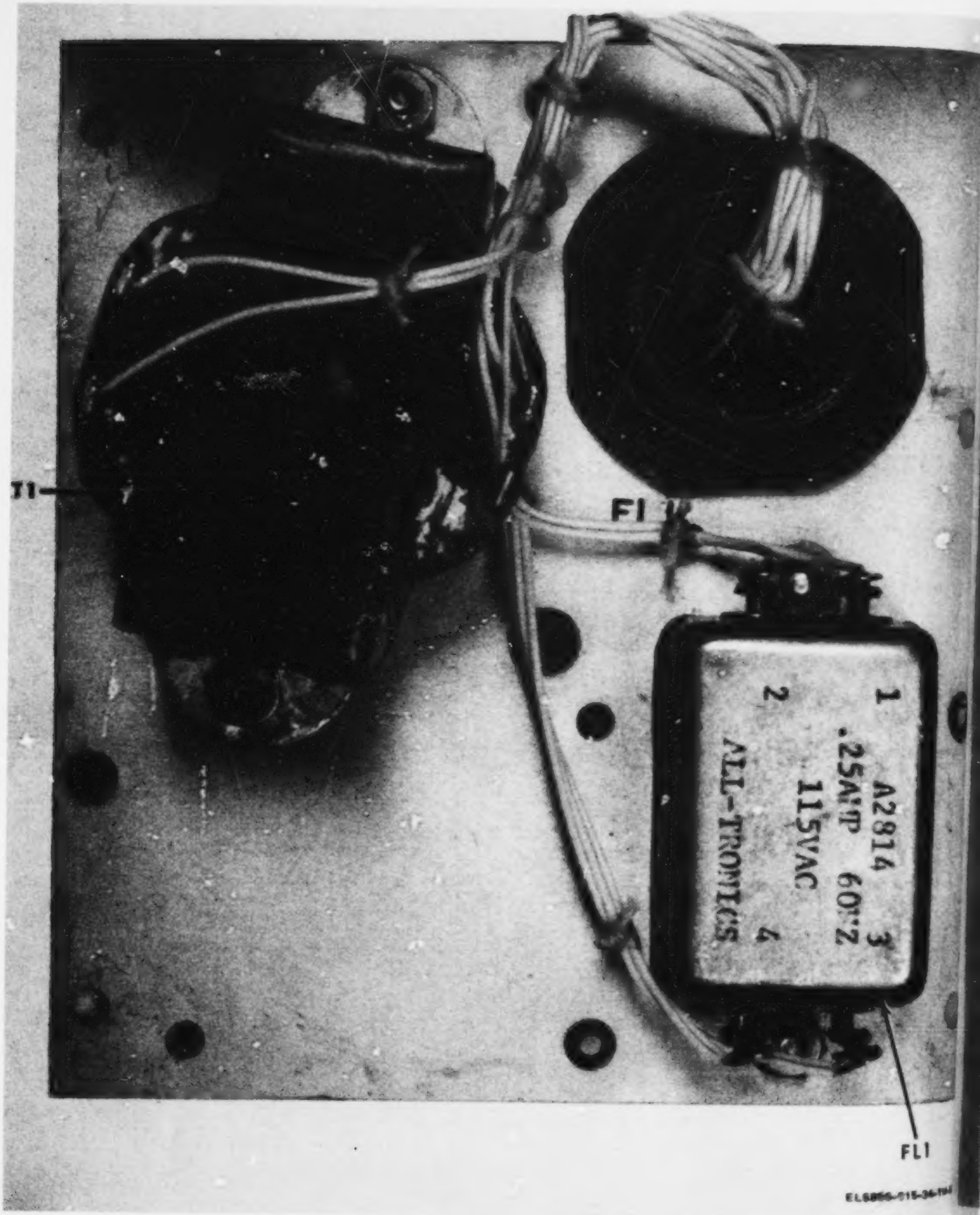

T1
FL1
1 A2814 3
.25AMP 60HZ
115VAC
2 ALL-TRONICS 4
FL1

Figure 3-5. Instrument servo assembly 14A8A1, A8A2, parts location (sheet 4 of 5).

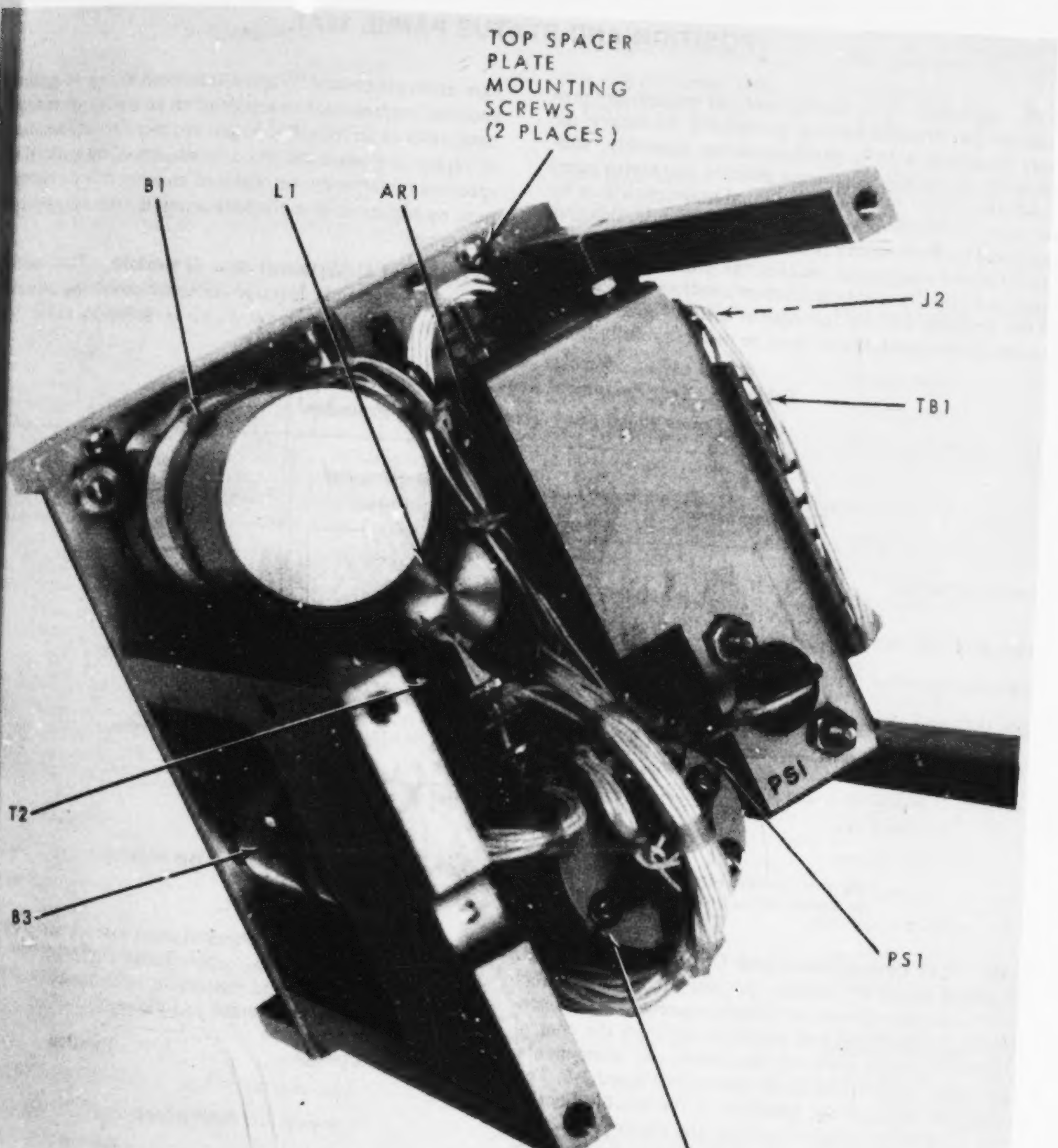

TOP SPACER PLATE MOUNTING SCREWS (2 PLACES)
B1
L1
AR1
J2
TB1
T2
B3
PS1
PS1
B2
EL5895-915-34-TM-23 ⑤

Figure 3-5. Instrument servo assembly 14A8A1, A8A2, parts location (sheet 5 of 5).

SECTION IV. TROUBLESHOOTING OF ANTENNA POSITION AND STATUS PANEL 14A7

3-16. General. This section contains preliminary procedures and troubleshooting procedures necessary for fault localization to a malfunctioning assembly, subassembly, or module of antenna position and status panel 14A7 after referral by organizational maintenance or by the servo and control equipment group troubleshooting (section 11). Preliminary procedures consist of obtaining the listed test equipment, making the prescribed connections, and initially setting equipment controls as specified. These settings, and all subsequent settings given in the troubleshooting procedure, must be made carefully to ensure accurate results. When a troubleshooting proced specifies replacement or repair of an assembly or com nent, refer to Section XII in this chapter for replacem of repair procedure. When a troubleshooting proced specifies replacement or repair of an assembly or com nent by higher level maintenance, notify the approp personnel.

3-17. Test Equipment and Materials. Test eq ment and materials required for troubleshooting ante position and status panel 14A7 is listed in table

Table 3-5 Test Equipment Required for Antenna Position and Status Panel 14A7 Troubleshooting Procedure

Common name	Part/model no.	Qty	Manufacturer
Circuit Card Extender	SM-D-724007 (see note)	1	Aeronutronic Ford
Milliammeter, Volt-Ohm- (VOM)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Probe, Oscilloscope, X1, X10	010-6063	2	Tektronix
Test Lead, Microgator Clip to Microgator Clip	1613-12	3	Pomona

NOTE

The circuit card extender supplied with special tools requires removal of the guides to permit engagement of the antenna position and status panel card connectors.

3-18. Test Connections and Conditions (fig. 3-6). Troubleshooting of antenna position and status panel 14A7 is performed with the chassis connected in the operational configuration and extended out from the control console to provide access to test points and components. Test points and test setup are shown in Figure 3-6. Test connection changes are specified in the troubleshooting table. Extend the antenna position and status panel chassis to the maintenance position by loosening the four captive screws securing the top card assemblies, loosen 18 captive screws securing the top cover to the chassis and remove the top cover, then loosen six captive scrfews securing the electrical equipment chassis cover and remove the cover.

3-19. Initial Control Settings. Antenna position and status panel 14A7 contains the key-operated antenna safe switch. The key must be turned clockwise for servo eq ment operation in any operational configuration should not be changed except for fault isolation. In test equipment settings are as follows.

Control	Position
Oscilloscope	
Power	Pull
VERT MODE	CHOP
CH1 & CH2 VOLTS/DIV	As required to observe signal
CH1 & CH2 AC-GND-DC	DC
HORIZ DISPLAY	A-LOCK KNOBS

Control	Position
Oscilloscope	
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER-SLOPE AND LEVEL	As required for stable display
TRIGGER HOLD OFF	NORM
10X MAG	OFF (out)
Function	+DC
Range	50V

-20. Troubleshooting Procedure. After completng the preliminary procedures, perform the necessary teps in table 3-6, as specified by the sympton/probable ause lising below. Antenna position and status panel 4A7 fault status and interlock circuits simplified schematic diagram (fig. FO-8) and panel schematic (fig. FO-) will assist in performing the troubleshooting procedures. Circuit card assembly schematics (fig. FO-10, FO-1, and FO-12) will also provide assistance for troublehooting the overall assembly. Refer to figure 3-7 for arts location. After the faulty item has been replaced, erform the servo and control equipment group performnce test described in section XIX of this chapter. Upon atisfactory completion of the performance test, the anenna position and status panel can be returned to service.

Symptom	Probable cause
TANDBY MODE indicator on antenna control panel is unlit but no STATUS indicator on antenna position and status panel is lit; all other MODE indicators are unlit.	Mode logic circuit card assembly A1 faulty. Refer to step 1a.
perator unable to advance to manual mode from standby mode; all STATUS indictors unlit.	Mode logic circuit card assembly A1 faulty. Refer to step 1d.
perator unable to advance to acquisition mode from manual mode; all STATUS indicators unlit.	Mode logic circuit card assembly A1 faulty. Refer to step 1g.
Operator unable to advance to slave mode from manual mode; all STATUS indicators unlit.	Mode logic circuit card assembly A1 faulty. Refer to step 1h.
Operator unable to select standby mode from any other mode; all STATUS indicators unlit.	Mode logic circuit card assembly A1 faulty. Refer to step 1b.
Antenna may be positioned in elevation axis but not azimuth with respective handcrank on antenna control panel; corresponding SLEW control operation is normal.	Mode logic circuit card assembly A1 or relay circuit card assembly A5 faulty. Refer to step 1d.
Antenna may be positioned in azimuth axis but not elevation with respective handcrank on antenna control panel; corresponding SLEW control operation is normal	Mode logic circuit card assembly A1 or relay circuit card assembly A5 faulty. Refer to step 1d.
Antenna may be positioned with EL SLEW control unit not with AZ SLEW control on antenna control panel; corresponding handcrank opertion normal.	Mode logic circuit card assembly A1, servo analog circuit card assembly A2, or relay circuit card assembly A5 faculty. Refer to step 1f.
Antenna may be positioned with AZ SLEW control but not with EL SLEW control on antenna control panel; corresponding handcrank.	Mode logic circuit card assembly A1, servo analog circuit card assembly A3, or relay circuit card assembly A5 faulty. Refer to step 1e.
ELEVATION/AXIMUTH antenna position indicator on antenna position and status panel does not follow antenna movement about monitored axis in any mode.	Transformer 1 or respective antenna position indicator DS1/DS2 faulty. Refer to step 9 (transformer T1) or step 4 (indicator DS1/DS2).
Unable to achieve autotrack mode	Mode logic circuit card

Symptom	Probable cause
from acquisition mode; handcrank and SLEW controls operation normal.	assembly A1 faulty. Refer to step 1c.
Servo and control equipment not tracking correctly but AUTOTRACK indicator on antenna control panel is lit.	Relay circuit card assembly A4 faulty. Refer to step 3.
AUTOTRACK indicator goes out and ACQUISITION indicator lights, indicating autotrack dropout; SCR FAILURE indicator remains unlit.	Relay circuit card assembly A5 faulty. Refer to step 3.
HANDCRANK ENGAGED indicator on antenna position and status panel is lit (amber).	Relay circuit card assembly A3 faulty. Refer to step 2.
STOW indicator on antenna position and status panel is lit (red).	Relay circuit card assembly A5 faulty. Refer to step 3.
POWER FAILURE indicator on antenna position and status panel is lit (red).	Relay K1, K2, or K3, relay circuit card assembly A7, or mode logic circuit card assembly A1 faulty. Refer to steps 1, 3, 5, 6 or 7.
EL MOTOR HOT Indicator on antenna position and status panel is lit (red).	Relay circuit card assembly A6 faulty. Refer to step 3.
AZ MOTOR HOT indicator on nna position and status panel is lit (red).	Relay circuit card assembly A6 faulty. Refer to step 3.
AZ SERVO LIMIT or EL SERVO LIMIT indicator on antenna control panel is lit (amber).	Relay circuit card assembly A4 faulty. Refer to step 3.
EL ELECT LIMIT indicator on antenna position and status panel is lit (red).	Relay circuit card assembly A3 faulty. Refer to step 2.

Symptom	Probable cau
AZ ELEC LIMIT indicator on antenna position and status panel is lit (red).	Relay circuit card assembly A5 faul Refer to step 3.
BRAKES MANUALLY RELEASED indicator on antenna position and status panel is lit (amber).	Relay circuit card assembly A6 faul Refer to step 3.
SCR FAILURE indicator on antenna position and status panel is lit (red).	Relay circuit card assembly A7 faulty. Refer to step 3.
ANTENNA SAFE indicator on antenna position and status panel is lit (white)	Relay circuit card assembly A5 or antenna safe switch S1 faulty Refer to step 3 (relay card A5) or step 8 (switch S
MINOR DRIVE FAULT indicator on antenna position and status panel is lit (amber).	Relay circuit card assembly A6 faul Refer to step 3
AZIMUTH/ELEVATION handcrank inoperative in manual mode.	Servo analog circu card assembly A faulty. Refer 2a.
AZIMUTH/ELEVATION slew control inoperative in manual mode.	Servo analog circu card assembly A faulty. Refer 2b.
AZIMUTH/ELEVATION autotrack function inoperative.	Servo analog circu card assembly A faulty. Refer 2c and 2d.
Pressing MAINT switch does not inhibit audible alarm when a fault is present in the servo and control equipment.	MAINT switch S2 faulty. Refer step 10.

Table 3-6 Antenna Position and Status Panel 14A7 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	Mode logic circuit card assembly A1	Circuit card assembly A1 inputs/outputs are connected through circuit card extender; set up additional test conditions as listed below. To install circuit card extender, remove circuit card (section XII) and install extender in place of circuit card, then carefully install card on extender.	Connect vom (+) lead as indicated below; connect (-) lead to A1P4-6 for each measurement.	0 V (logic 0) for each test	If indication is abnormal for any test, replace A1.
		a. No fault is indicated on antenna position and status panel front panel; no MODE indicator is lit on antenna control panel.	a. A1P4-1		a. If indication is normal, check relay circuit card assembly A5 (step 3).
		b. Standby mode is selected.	b. A1P4-3		b. If indication is normal, proceed to step c.
		c. Manual or autotrack mode is selected.	c. A1P4-5		c. If indication is normal, check relay circuit card assembly A5 (step 3).
		d. Manual mode is selected.	d. A1P4-9, -21, -23		d. If all indications are normal, check relay circuit card assembly A5 (step 3).
		e. Manual mode is selected, ELEVATION SLEW control on antenna control panel is rotated clockwise.	e. A1P4-25		e. If indication is normal, check relay circuit card assembly A5 (step 3), and/or servo analog
		f. Manual mode is selected, AZIMUTH SLEW control antenna control panel is rotated clockwise.	f. A1P4-27		f. If indication is normal, check relay circuit card assembly A5 (step 3), and/or servo analog circuit card assembly A2 (step 2).
		g. Mode logic is sequenced through manual mode to acquisition mode.	g. A1P4-11		g. If indication is normal, proceed to step h.
		h. Mode logic is sequenced through manual mode to slave mode, A1P3-11 is jumpered to A1P3-12 with 1613-12 test lead.	h. A1P4-13, P4-15		h. If indication is normal, check relay circuit card assembly A4 and/or A7 (step 3). Remove jumper at P3-11 and 12.
		i. Mode logic is sequenced through manual mode to acquisition mode. A1P3;13 is jumpered to A1P3-18.	i. A1P4-17, P4-19		i. If indication is normal, check relay circuit card assembly A4 and/or A7 (step 3). Remove jumper at P3-13 and P3-18.
		j. Mode logic is sequenced through manual mode to acqui sition mode. A1P3-15 is jumpered to A1P3-18.	j. A1P4-28		j. If indication is normal, check relay circuit card assembly A7 (step 3). Disconnect vom and jumpers from A1. Remove A1 from extender, remove extender, and reinstall circuit card (section XII).
	Servo analog circuit card assembly A2/	a. Manual mode is selected. AZIMUTH/	a. As shown by dashed lines on figure 3-6	a. (1) Oscilloscope chan-	a. If sine waves are present and voltage is not as specified, replace A2/A3

Table 3-6 Antenna Position and Status Panel 14A7 Troubleshooting Procedure - Continued

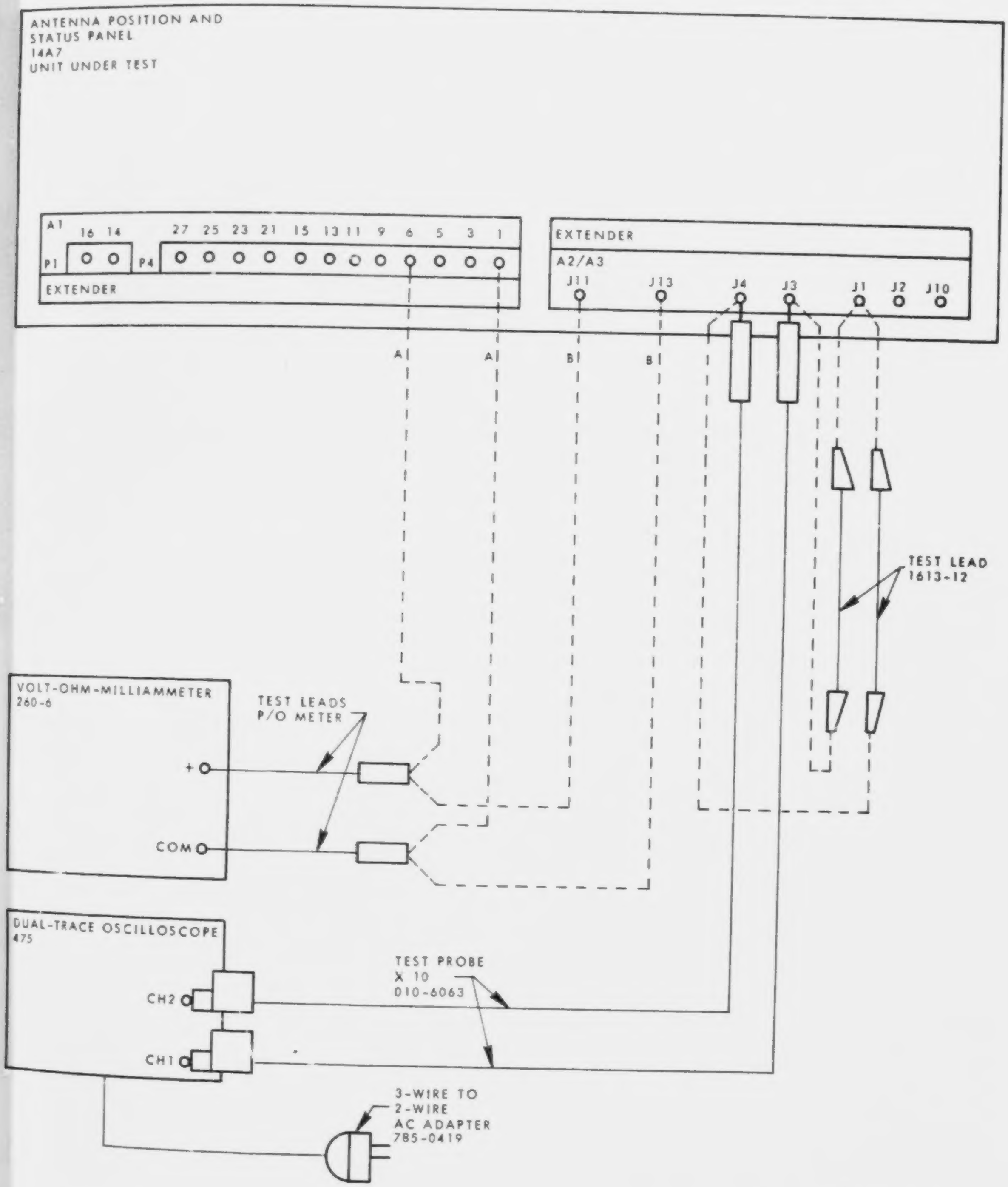
Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	A3	ELEVATION handcrank on antenna control panel is operated clockwise 1/4 turn. Set vom range switch . to 10 V.		nel 1 displays a sine wave with a small (less than 2 V peak-to-peak) signal level. (2) Oscilloscope channel 2 displays a sine wave, the amplitude of which is 64 V (peak-to-peak). (3) vom indication is approximately 3.2 times channel 1 signal levels.	(section XII); if both indicat normal, perform step c below
		b. Manual mode is selected, AZIMUTH/ELEVATION SLEW control is rotated clockwise to cw dot.	b. Same as step a, except connect oscilloscope (CH1 only) to A2A3J10 (+).	b. (1) Oscilloscope displays a (-) dc signal. (2) Vom indication is approximately 0.67 x peak signal level displayed on oscilloscope.	b. If oscilloscope display is norm vom signal level indication is a mal, replace A2/A3.
		c. Satellite is acquired (Ref TM 11-5895-898-12 or TM 11-5895-899-12). Generate tracking error signal as follows: Press MANUAL MODE indicator switch on antenna control panel and turn handcrank 0.06 degrees CW to obtain a reduction of approximately 3 dB on tracking demodulator SIGNAL STRENGTH meter. Maintain this same dB level during the test.	c. Same as step a except connect oscilloscope (CH1 only) to A2/A3J2 (+).	c. Oscilloscope displays a ramp signal approximately 1.5 V peak-to-peak, riding a positive dc level	c. If oscilloscope display is norm vom signal level is abnorma A2/A3.
		d. Press ACQUISITION/AUTOTRACK indicator switch and read max vom indication.	d. None	d. Vom indication is approximately 1.43 x peak signal level displayed on oscilloscope. NOTE For A2 only,	d. If both indications are norm store equipment to normal

Table 3-6 Antenna Position and Status Panel 14A7 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
				angles near 90 degrees, the 1.43 gain figure increases. This is normal and should be ignored.	
3	Relay circuit card assembly A4-A7	Normal mode	None		Troubleshoot any relay circuit card assembly A4 through A7 by replacing suspected faulty circuit card with one of the other relay circuit cards. If fault is cleared, install spare circuit card.
	Azimuth/elevation antenna indicator DS1/DS2				Check transformer T1 as described in step 9. If transformer T1 is normal, troubleshoot DS1/DS2 by replacing the suspected faulty synchro with a spare synchro (section XII). If symptom remains on the same antenna position indicator, replace dial assembly (section XII).
	Relay K1	Bottom cover removed (section XII)	Connect vom (+) lead to K1-3, (-) lead to chassis ground.	+5 V dc ±0.5 V	If indication is abnormal, replace K1 (section XII). If indication is normal, perform step 6.
	Relay K2	Bottom cover removed (section XII)	Connect vom (+) lead to K2-3, (-) lead to chassis ground.	+15 V ±0.5 V dc	If indication is abnormal, replace K2 (section XII). If indication is normal, perform step 7.
	Relay K3	Bottom cover is removed (section XII). Set vom function switch to -DC.	Connect vom (+) lead to K3-7, (-) lead to chassis ground.	-15 V ±0.5 V dc	If indication is abnormal, replace K3 (section XII).
	Antenna safe switch S1	ANTENNA SAFE switch unsafed, circuit card A5 on extender (section XII)	Connect vom (+) lead to A5:3-23 and (-) lead to chassis ground.	26 ±2.6 V dc	If indication is abnormal, replace S1 (section XII). If indication is normal, replace circuit card A5.
	Transformer T1	Set vom to 250 V ac.	Connect vom to T1-1 and 8.	105 ±10 V ac	If indication is abnormal, replace T1 (section XII). If indication is normal, perform step 4.
	Maintenance switch	Bottom cover is re-	Connect vom (+) lead to	+26 ±2.6 V dc	If indication is abnormal, replace S2

Table 3-6 Antenna Position and Status Panel 14A7 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	S2	moved (section XII). MAINT switch is pressed to maintenance mode. Set vom to 50 V dc.	stack No. 1, S2-NO and (-) lead to chassis ground.		(section XII).


ANTENNA POSITION AND
STATUS PANEL
14A7
UNIT UNDER TEST
A1
16
14
27
25
23
21
15
13
11
9
6
5
3
1
P1
P4
EXTENDER
EXTENDER
A2/A3
J11
J13
J4
J3
J1
J2
J10
A
A
B
B
TEST LEAD
1613-12
VOLT-OHM-MILLIAMMETER
260-6
TEST LEADS
P/O METER
+
COM
DUAL-TRACE OSCILLOSCOPE
475
CH2
CH1
TEST PROBE
X 10
010-6063
3-WIRE TO
2-WIRE
AC ADAPTER
785-0419

EL5895-915-34-TM-24

Figure 3-6. Antenna position and status panel 14A7, troubleshooting, test setup diagram.

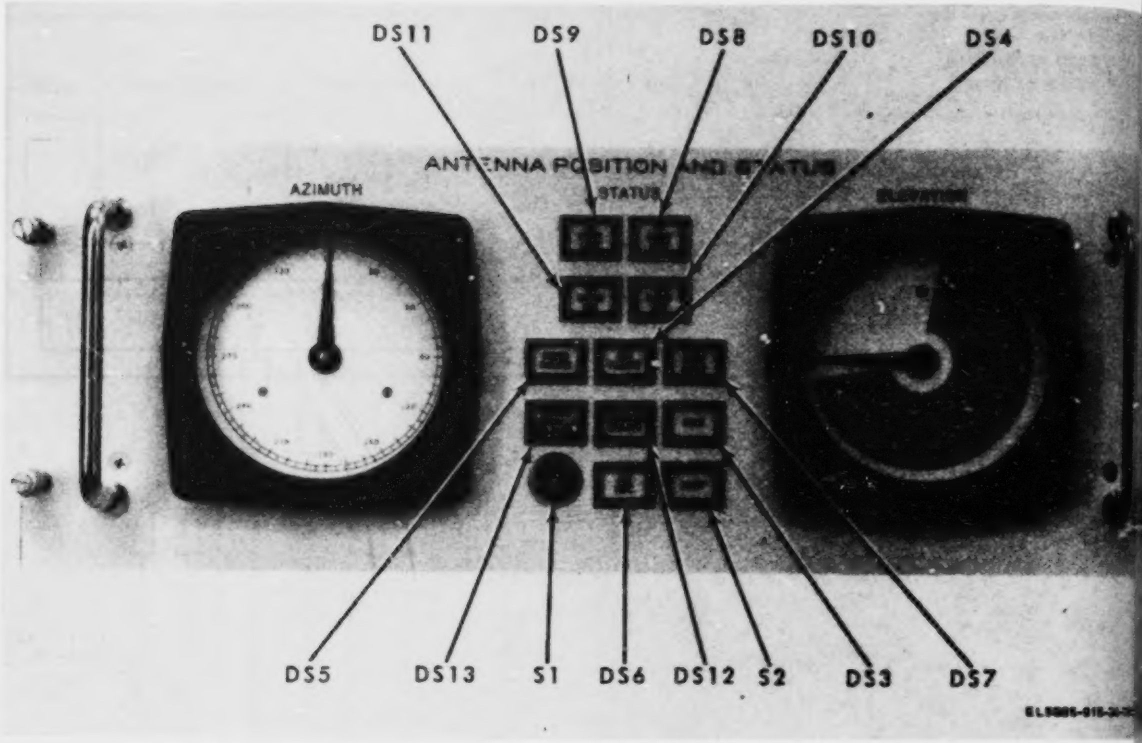

DS11
DS9
DS8
DS10
DS4
ANTENNA POSITION AND STATUS
AZIMUTH
STATUS
DS5
DS13
S1
DS6
DS12
S2
DS3
DS7

Figure 3-7. Antenna position and status panel 14A7, parts location (sheet 1 of 3).

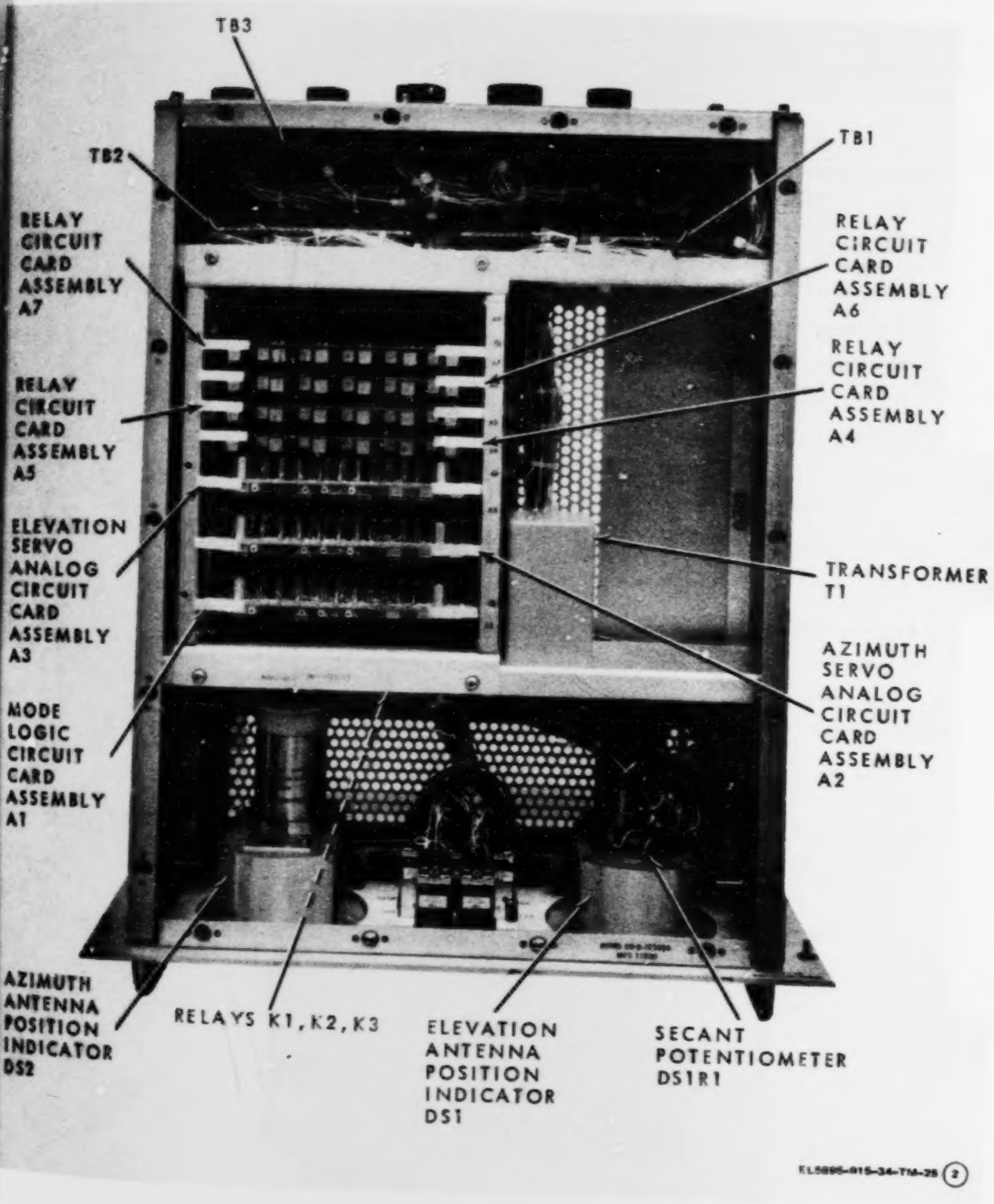

TB3
TB2
TB1
RELAY CIRCUIT CARD ASSEMBLY A7
RELAY CIRCUIT CARD ASSEMBLY A6
RELAY CIRCUIT CARD ASSEMBLY A5
RELAY CIRCUIT CARD ASSEMBLY A4
ELEVATION SERVO ANALOG CIRCUIT CARD ASSEMBLY A3
TRANSFORMER T1
MODE LOGIC CIRCUIT CARD ASSEMBLY A1
AZIMUTH SERVO ANALOG CIRCUIT CARD ASSEMBLY A2
AZIMUTH ANTENNA POSITION INDICATOR DS2
RELAYS K1,K2,K3
ELEVATION ANTENNA POSITION INDICATOR DS1
SECANT POTENTIOMETER DS1R1
EL5895-915-34-TM-25 ②

Figure 3-7. Antenna position and status panel 14A7, parts location (sheet 2 of 3)

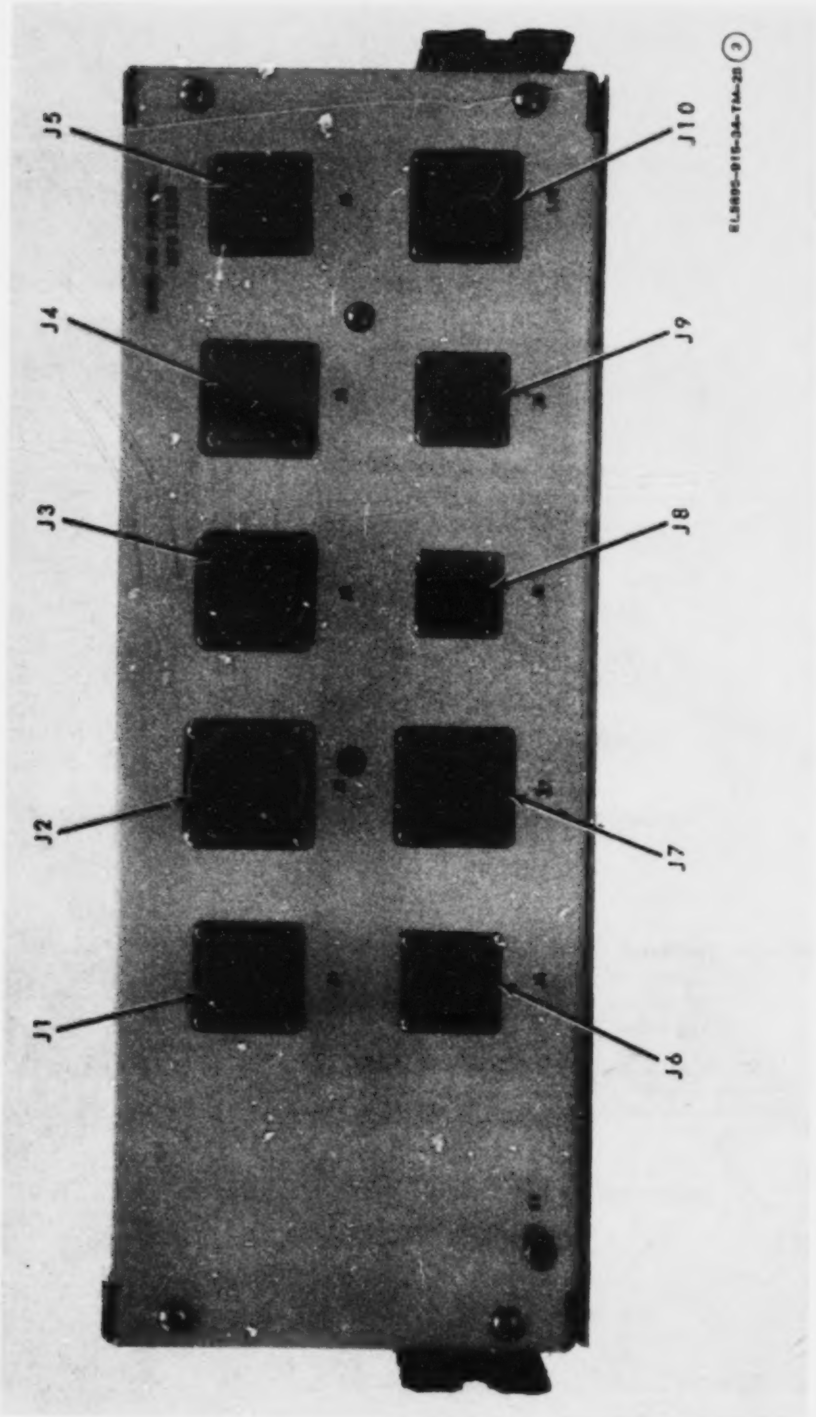

J5
J4
J3
J2
J1
J10
J9
J8
J7
J6
EL5895-915-34-TM-25 ③

Figure 3-7. Antenna position and status panel 14A7, parts location (sheet 3 of 3).

SECTION V. TROUBLESHOOTING OF SERVO POWER SUPPLY ASSEMBLY 14A9

3-21. General. This section contains preliminary procedures and troubleshooting procedures necessary for fault localization to a malfunctioning assembly, subassembly, or module of servo power supply assembly 14A9 after referral by organizational maintenance or by servo and control equipment group troubleshooting (section II). This section also includes the procedures necessary for bench testing the repairable power supplies (PS2 through PS4). Preliminary procedures consist of obtaining the listed test equipment, making the prescribed test connections, and initially setting equipment controls as specified. These settings and all subsequent settings given in the troubleshooting chart must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement, repair, or adjustment of a malfunctioning assembly or component, refer to section XIII in this chapter for the maintenance procedure. When a troubleshooting procedure specifies replacement, repair, or adjustment of an assembly or component by higher level maintenance, notify the appropriate personnel.

3-22. Test Equipment and Materials. The only test equipment required for troubleshooting the servo power supply assembly is a 260-6 vom. Test leads required are supplied with the vom.

3-23. Test Connections and Conditions (fig. 3-8). Troubleshooting of the servo power supply assembly is performed with the chassis connected in the operational configuration and extended out from the control console, to provide access to test points and components. Test points are shown in figure 3-8. Test connection changes are specified in the troubleshooting table. To extend the servo power supply chassis to the maintenance position, oosen the four captive screws and pull the chassis out to he mechanical stops.

-24. Initial Control Settings. The servo power upply assembly circuit breakers should be set for online ystem operation and should be changed only as necessary for fault isolation. Set the vom switches as indicated in able 3-7.

-25. Troubleshooting Procedure. After completng the preliminary procedures, perform the necessary steps in table 3-7, as specified by symptom/probable cause listing below. Servo power supply assembly schematic diagram fig. FO-13) will assist in performing the troubleshooting procedures. Refer to figure 3-9, sheets 1, 2, and 3, for parts location. After the faulty item has been repaired or replaced, perform the testing procedures, described in section XIX of this chapter. Upon satisfactory completion of the performance test, the servo power supply assembly can be returned to full service.

Symptom	Probable cause
STANDBY mode indicator on antenna control panel is off but no FAULT indicator on antenna position and status panel is lit, and other MODE indicators are off.	26 V dc power supply PS1 circuit faulty. Refer to step 1.
POWER FAILURE indicator on antenna position and status panel is lit (red).	a. +15 V dc power supply PS2 circuit faulty. Refer to step 2. b. -15 V dc power supply PS3 circuit faulty. Refer to step 3. c. +5 V dc power supply PS4 circuit faulty. Refer to step 4. d. Transformer T1 faulty. Refer to step 5.

Table 3-7 Servo Power Supply Assembly 14A9 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional chec and remarks
1	26 V dc power supply PS1, 26 V dc PRIMARY POWER CIRCUIT BREAKER CB3, 26 V dc OUTPUT EQPT circuit breaker CB7, and meter circuit M1, R5, and S1.	Servo and control equipment is operational, CB3 set to ON, CB7 set to ON, MONITOR switch set to +26 V dc.	None	VOLTAGE meter indicates in green area.	If voltage is indicat below normal, adj er supply (section X If not able to adju place power supp volts is indicated, p substep a.
		a. Set vom function switch to +DC and range switch to 50 V.	a. Connect vom to TB1-7 (+) and TB1-9 (gnd).	a. +26 ±0.13 V dc	a. If reading is normal: S1, R5 (on TB2), a with vom and repla faulty component XIII): if reading is mal, per form subs
		b. MONITOR switch is set to OFF.	b. Connect vom to TB1-8 (+) and TB1-9 (gnd).	b. +26 ±0.13 V dc	b. If reading is norma place CB7 (section if reading is abnorm perform substep c
		c. Vom is set to AC 250 V range.	c. Connect vom to CB3 LINE terminal (+) and TB1-3 (gnd).	c. 120 ±12 V ac	c. If reading is norma place PS1; if readi abnormal, replace C (section XIII).
2	+15 V dc power supply PS2, overvoltage protector Z1, circuit breaker CB5, and meter circuit M1, R4, and S1.	Servo and control equipment is operational, CB5 set to ON, and MONITOR switch set to +15 V dc.	None	VOLTAGE meter indicates in green area.	If voltage is indicat below normal, adju er supply (section X volts is indicated, p substep a.
		a. Vom is set to +DC on 50 V range.	a. Connect vom to PS2 output, pins 6 (+) and 4 (rtn).	a. +15 ±0.75 V dc	a. If reading is norma check S1, R4 (on T and M1 with VOM replace faulty comp (section if reading normal, perform su b.
		b. MONITOR switch is set to OFF.	b. +15V power supply output lead is disconnected from pin 6, vom is connected as in a above	b. +15 ±0.75 V dc	b. If reading is norma just overvoltage pr overvoltage thresh replace overvoltage tector Z1; if readi high, adjust power

Table 3-7 Servo Power Supply Assembly 14A9 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
		c. VOM is set to AC on 250 V range.	c. Power supply output lead is reconnected to pin 6, vom is connected to power supply a-c input terminals 1 and 2.	c. 120 ±12 V ac	output voltage (section XIII); if reading is 0 volts, perform substep c. c. If reading is normal, troubleshoot PS2 (para 3-26); if reading is abnormal, replace CB5 (section XIII).
3	-15 V dc power supply PS3, overvoltage protector Z2, circuit breaker CB4, and meter circuit M1, R4, and S1.	Servo and control equipment is operational, CB4 set to ON, and MONITOR switch set to -15 V dc.	None	VOLTAGE meter indicates in green area.	If voltage is indicated but is below normal, adjust power supply (section XIII). If 0 volts is indicated, perform substep a.
		a. VOM is set to -DC on 50 V range.	a. Connect vom to PS3 output pins 4 (-) and 6 (rtn).	a. -15 ±0.1 V dc	a. If reading is normal,check S1, R4 (on TB2), and M1 with vom and replace faulty component (section XIII); if reading is abnormal, perform substep b.
		b. MONITOR switch is set to OFF.	b. Output lead is disconnected from pin 4, vom is connected as in a above.	b. -15 ±0.75 V dc	b. If reading is normal, adjust overvoltage protector overvoltage threshold or replace over voltage protector Z2; if reading is high, adjust power supply output voltage (section XIII); if reading is 0 volts, perform substep c.
		c. Vom is set to AC on 250 V range.	c. Power supply output lead is reconnected to pin 4, vom is connected to power supply a-c input terminals 1 and 2.	c. 120 ±12 V ac	c. If reading is normal, troubleshoot PS3 (para 3-26); if reading is abnormal, replace CB4 (section XIII)
	+5 V dc power supply PS4, overvoltage protector Z3, circuit breaker CB2, and meter circuit M1, R3, and S1.	Servo and control equipment is operational, CB2 set to ON, and monitor switch set to +5 V dc.	None	VOLTAGE meter indicates in green area.	If voltage is indicated but is below normal, adjust power supply output voltage (section XIII). If 0 volts is indicated, perform substep a.
		a. Vom is set to +DC on 10 V range.	a. Connect vom to PS4 output, pins 6 (+) amd 4 (rtn).	a. +5 ±0.25 V dc	a. If reading is normal, check S1, R3 (on TB2), and M1 with vom and replace faulty component (section XIII); if reading is abnormal, perform substep b.
		b. MONITOR switch is set to OFF.	b. Output lead is disconnected from pin 6, vom is connected as in a above.	b. +5 ±0.1 V dc	b. If reading is normal, adjust overvoltage protector overvoltage threshold or replace overvoltage pro

Table 3-7 Servo Power Supply Assembly 14A9 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional che and remark
					tector 23; if readi high, adjust powe (section XIII); if is 0 volts, perform c.
		c. Vom is set to AC on 250 V range.	c. Power supply output lead is reconnected to pin 6, vom is connected to power supply a-c input terminals 1 and 2.	c. 120 ±12 V ac	If reading is normal bleshoot PS4 (par if read ing is abno replace CB2 (secti XIII).
5	Transformer T1 and circuit breaker CB1.	Servo and control equipment is operational, CB1 set to ON, vom set to AC on 50 V range.	Connect vom to T1-3 and T1-5.	22 ±3 V ac	If reading is out of t ance, replace T1 (XIII); if reading i form the following vom to 250 V rang connect to T1-1 an vom indication is 1 V ac, replace T1; i cation is 0, replace (section XIII).

3-26. Power Supplies Troubleshooting. This paragraph contains troubleshooting procedures for localizing a fault to a malfunctioning component in 15 V dc power supplies 14A9PS2 and 14A9PS3 and in 5 V dc power supply 14A9PS4. These procedures are to be performed with the power supplies on the bench.

a. Test Equipment and Materials. Table 3-8 lis equipment and materials required for troubleshooti power supplies.

Table 3-8 Test Equipment Required for Power Supply 14A9PS2, A9PS3, A9PS4 Troubleshooting Procedure

Common name	Part/model no.	Qty	Manufactur
AC Line Cord	17449-S	1	Belden
Adapter, AC, 3-Wire to 2-Wire	785-0419	1	Allied
Adapter, Banana Jack to Spade Lug	3744	3	Pomona
Adapter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Meter, Multifunction	3450B	1	Hewlett-Packar
Milliammeter, Volt-Ohm-	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Alligator Clip	1166-36-B	2	Pomona

Table 3-8 Test Equipment Required for Power Supply 14A9PS2, A9PS3, A9PS4 Troubleshooting Procedure - Continued

Common name	Part/model no.	Qty	Manufacturer
Test Lead, Banana Plug to Alligator Clip	1166-36-R	1	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(B)	2	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(R)	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
Transformer, Variable	3PN2210	1	Staco

b. Test Connections and Conditions (fig 3-10). Power supply troubleshooting is accomplished in a bench test setup. Test connections are illustrated in figure 3-10. Prepare the equipment for troubleshooting as follows:

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

(3) On power supply, verify jumper wires are connected between terminals 3 and 4 and between terminals 6 and 7.

(4) Remove power supply cover. (Refer to section XIII.)

(5) Connect test equipment as shown in figure 3-10.

c. Initial Control Settings. Initial control settings for the troubleshooting procedure are as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	AC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT

Control	Position
Multifunction meter	
Oscilloscope	
POWER	On (Pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe signal
CH1 AC-GND-DC	AC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER SLOPE and LEVEL	As required for stable display.
Variable transformer	
Power switch	ON

d. Troubleshooting Procedures. Tables 3-9 and 3-10 provide step-by-step troubleshooting procedures to isolate a malfunction to a faulty part. Table 3-9 is for +15 V dc and -15 V dc power supplies PS2 and PS3; table 3-10 is for +5 V dc power supply PS4. Perform the procedures in the sequence given until the malfunction is found. If a faulty part is found, replace the part as described in section XIII test the power supply as described in section XXIV or XXV. Use the schematic diagrams (fig. FO-14 and FO-15) as an aid to locating trouble causes. Refer to figure 311, sheets 1 through 6, and figure 3-12, sheets 1 through 6, for parts location.

Table 3-9 15 V DC and -15 V DC Power Supply 14A9PS2, A9PS3 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Power transformer T1 auxiliary rectifier secondary.	As specified in paragraph 3-26b.	As specified in paragraph 3-26b, with multifunction meter connected between terminals B13 and B17 on pc board B.	22.5 ±2 V ac	Check C1 for a short. Chec for open or shorted cond Replace faulty item.
2	Power transformer T1 main rectifier secondary		Connect multifunction meter across capacitor C11 on terminal board E.	25.6 ±2.5 V ac	Check C11 for shorted cond Check T1 for open or shor condition. Replace faulty
3	Main rectifier circuit	Multifunction meter: press DC FUNCTION switch.	Connect multifunction meter test leads to power supply as follows: Test lead / Power supply -(blk) TB1-6 +(red) Term B5 on PC board B.	20.2 ±2 V dc	Check C9, CR8 through C and C8 for a shorted or o condition. Replace faulty ponent.
4	Bias supply		Connect multifunction meter test leads to power supply as follows: Test lead / Power supply -(blk) TB1-6 +(red) Junction or R5 and R6 (outboard side of R10)	9.1 ±0.1 V dc	Check CR7, C7, and CR6 shorted or open condition place faulty component.
5	Bias supply		Connect multifunction meter test leads to power supply as follows: Test lead / Power supply -(blk) TB1-6 +(red) Junction of R3 and R4 (inboard side of	6.1 ±0.5 V dc	Check CR1, R5, R4, and shorted or open compon Replace faulty item.
6	Series voltage regulator circuit.		Connect multifunction meter test leads to power supply as follows: Test lead / Power supply -(blk) TB1-4 +(red) TB1-6	15 ±0.15 V dc	a. If voltage is present but within tolerance, adjust control R1. If voltage ca be adjusted with R1, che with ohmmeter for short open condition. Replace necessary. b. If R1 is not faulty, pow supply may be operating constant current source rent limit value. Check a ment of overcurrent con

Table 3-9 15 V DC and -15 V DC Power Supply 14A9PS2, A9PS3 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
					R17 (para 3-72) and check series regulator circuit with ohmmeter for shorted components. Replace faulty component. c. If output voltage is too high, check R1 with ohmmeter for open condition. Check Q8, Q9, Q5, Q6, and Q1 for shorted condition. Check CR1 for open condition. Replace faulty component. d. If output voltage is too low, check Q2 and Q3 with ohmmeter for shorted condition and check R28 and R17 for open condition. Replace faulty component.
7	Filter circuits	Twist oscilloscope test leads to cancel external noise signals when measuring ripple voltage.	Connect oscilloscope test leads to power supply as follows: Scope lead Power supply -(blk) TB1-3 +(red) TB1-7	Equal to or less than 3 mV ripple	a. If ripple is at the line frequency or twice line frequency, check CR7 through CR11 for a shorted or open condition. Check C1, C7, and C8 for open conditions. Replace faulty item. b. If large spikes are present, check C2 and C3 for an open condition. Replace faulty item.

Table 3-10 5 V DC Power Supply 14A9PS4 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	Power transformer T1 auxiliary rectifier secondary	As specified in paragraph 3-26b.	As specified in paragraph 3-26b with multifunction meter connected between terminals B13 and B17 on	22 ±2 V ac	Check C1 for a short: replace as necessary. Check T1 for open or shorted condition. Replace faulty item.
	Power transformer T1 main rectifier secondary		Connect multifunction meter between terminal B2 on pcb B and terminal E5 on board E; then between terminals B2 and E4.	13.2 ±1.5 V ac	Check T1 for shorted or open condition. Replace if necessary.
	Main rectifier circuit	Multifunction meter: press DC FUNCTION switch.	Connect multifunction meter test leads to power supply	13.7 ±1.5 V dc	Check C9, CR9, CR11, C10, and C8 for shorted or open condition.

Table 3-10 5 V DC Power Supply 14A9PS4 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
			as follows: Test lead / Power supply -(blk) TB1-6 +(red) Term B5 on pcb B.		Replace faulty component.
4	Bias supply		Connect multifunction meter test leads to power supply as follows: Test lead / Power supply -(blk) TB1-6 +(red) Junction of R5 and R6 (out board side of R10)	9.1 ±0.1 V dc	Check CR7, C7, and CR6 for shorted or open condition. Repl faulty component.
5	Bias supply		Connect multifunction meter test leads to power supply as follows: Test lead / Power supply -(blk) TB1-6 +(red) Junction of R3 and R4 (inboard side of R3)	6.1 ±0.5 V dc	Check CR1, R5, R4, and R3 for shorted or open condition. Repl faulty component.
6	Series voltage regulator circuit		Connect multifunction meter test leads to power supply as follows: Meter lead / Power supply -(blk) TB1-4 +(red) TB1-6	5 ±0.5 V dc	a. If voltage is present but not w in tolerance, adjust VDC contr R1. If voltage cannot be adjus with R1, check R1 with ohmme for shorted or open condition. R place if necessary. b. If R1 is n faulty, power supply may be op ating as constant current sour current limit value. Check adju ment of overcurrent control R (para 3-73) and check series re lator circuit with ohmmeter for shorted components. Replace faulty item. c. If output voltage is too high, check R1 with ohmmeter for op condition, check Q8, Q5, and Q for shorted condition. Check C for an open condition. Replace faulty item. d. If output voltage is too low, ch Q2 and Q3 with ohmmeter for shorted condition and check R and R17 for open condition. R

Table 3-10 5 V DC Power Supply 14A9PS4 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
					place faulty item.
7	Filter circuits	Twist oscilloscope test leads to cancel external noise signals when measuring ripple voltage.	Connect oscilloscope test leads to power supply as follows: Scope lead / Power supply -(blk) TB1-3 +(red) TB1-7	Equal to or less than 3 mV	a. If ripple is at the line frequency or twice the line frequency, check CR7, CR9, and CR11 for a shorted or open condition. Replace as necessary. Check C1, C7, and C8 for open conditions. Replace faulty item. b. If large spikes are present, check C9, C10, and C2 for an open condition. Replace faulty item.

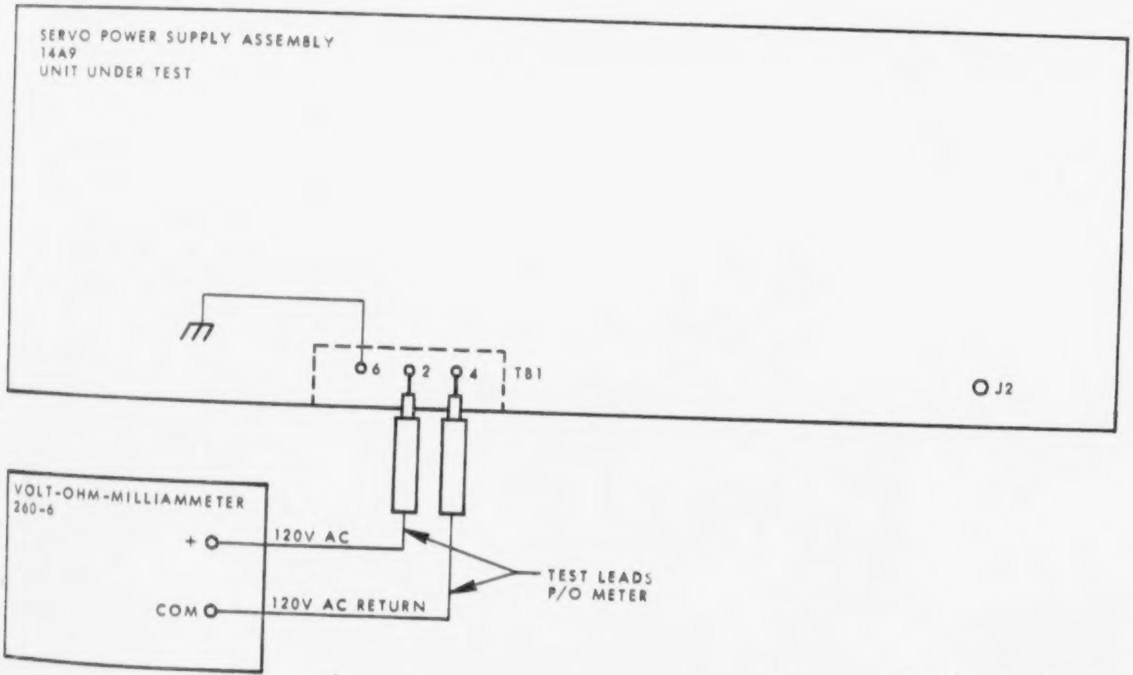
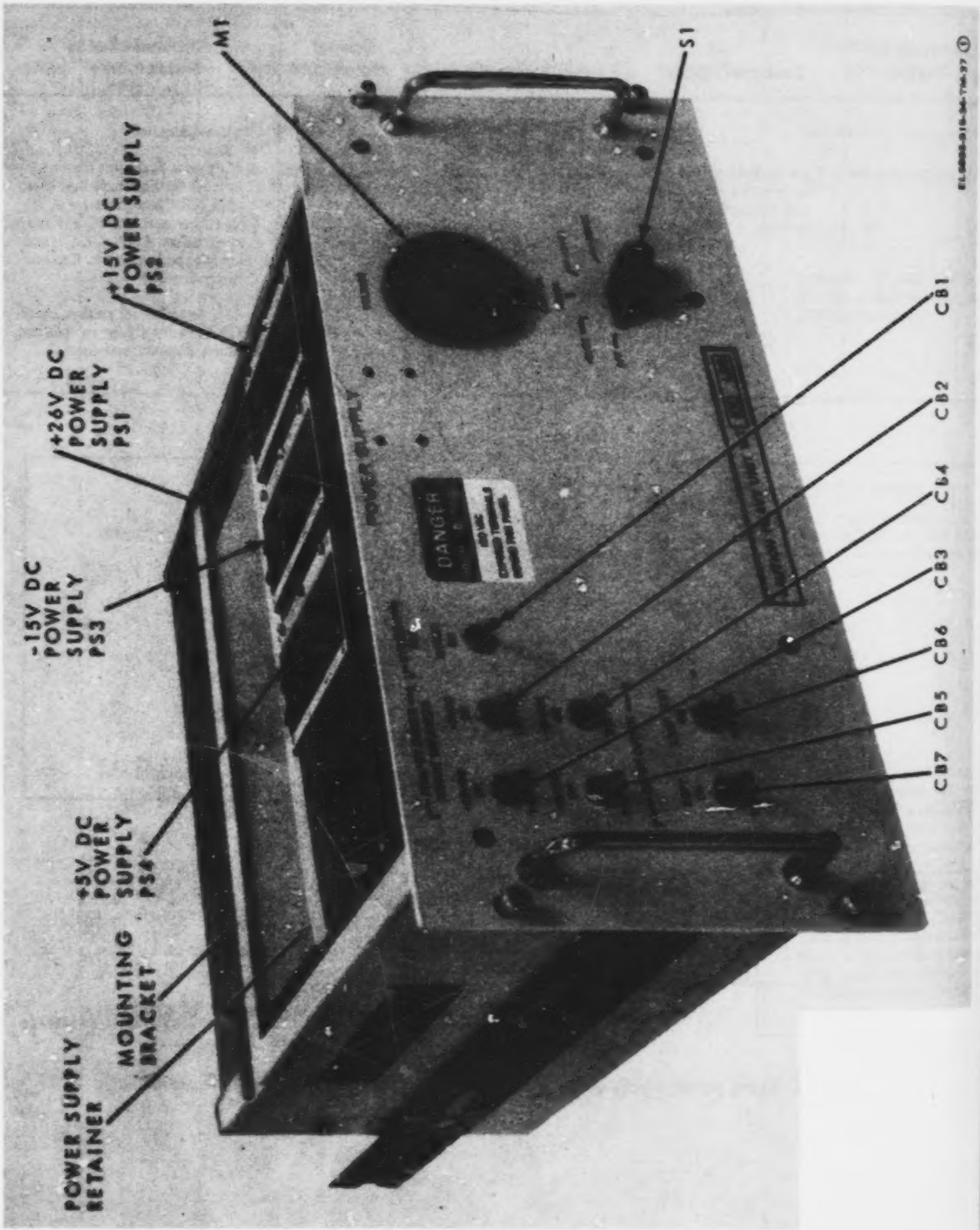

SERVO POWER SUPPLY ASSEMBLY
14A9
UNIT UNDER TEST
6
2
4
TB1
J2
VOLT-OHM-MILLIAMMETER
260-6
+
COM
120V AC
120V AC RETURN
TEST LEADS
P/O METER
EL5895-915-34-TM-26

Figure 3-8. Servo power supply assembly 14A9, troubleshooting, test setup diagram.


POWER SUPPLY RETAINER
MOUNTING BRACKET
+5V DC POWER SUPPLY PS4
-15V DC POWER SUPPLY PS3
+26V DC POWER SUPPLY PS1
+15V DC POWER SUPPLY PS2
M1
S1
CB1
CB2
CB4
CB3
CB6
CB5
CB7
DANGER
POWER SUPPLY
EL5895-915-34-TM-27 ①

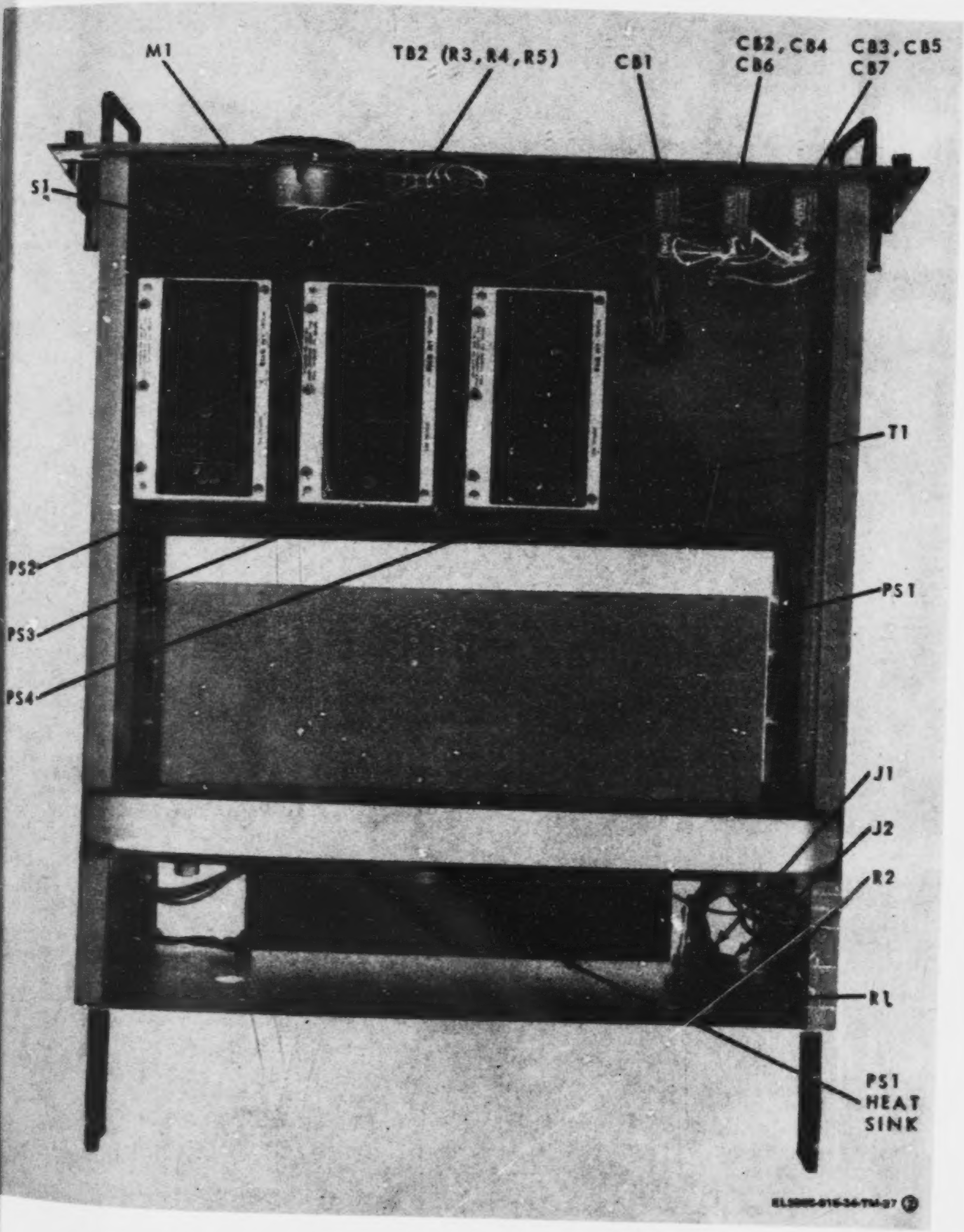

M1
TB2 (R3, R4, R5)
CB1
CB2, CB4
CB6
CB3, CB5
CB7
S1
T1
PS2
PS3
PS4
PS1
J1
J2
R2
R1
PS1
HEAT
SINK
EL5895-915-34-TM-27 ②

Figure 3-9. Servo power supply assembly 14A9, parts location (sheet 2 of 3)

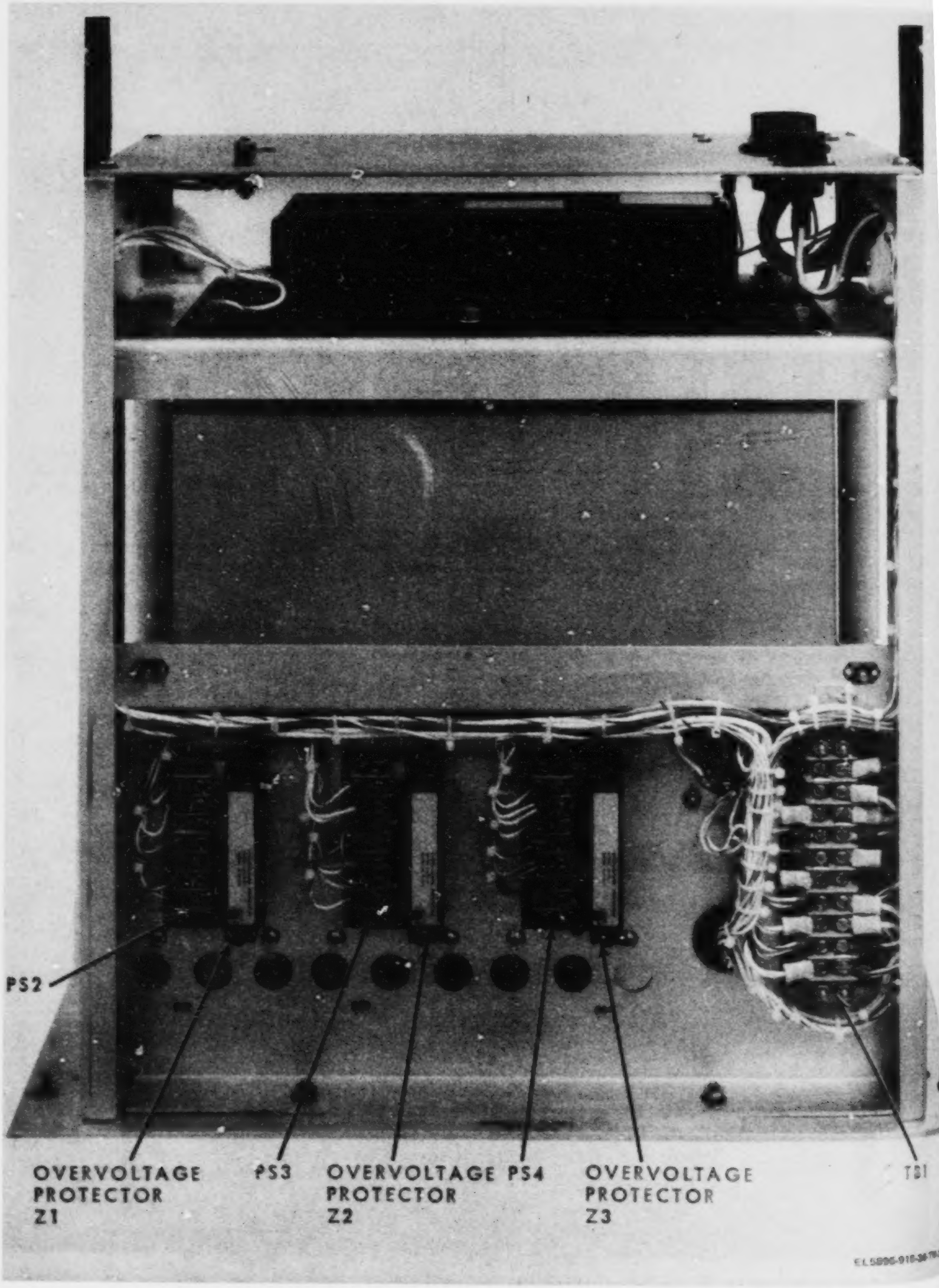
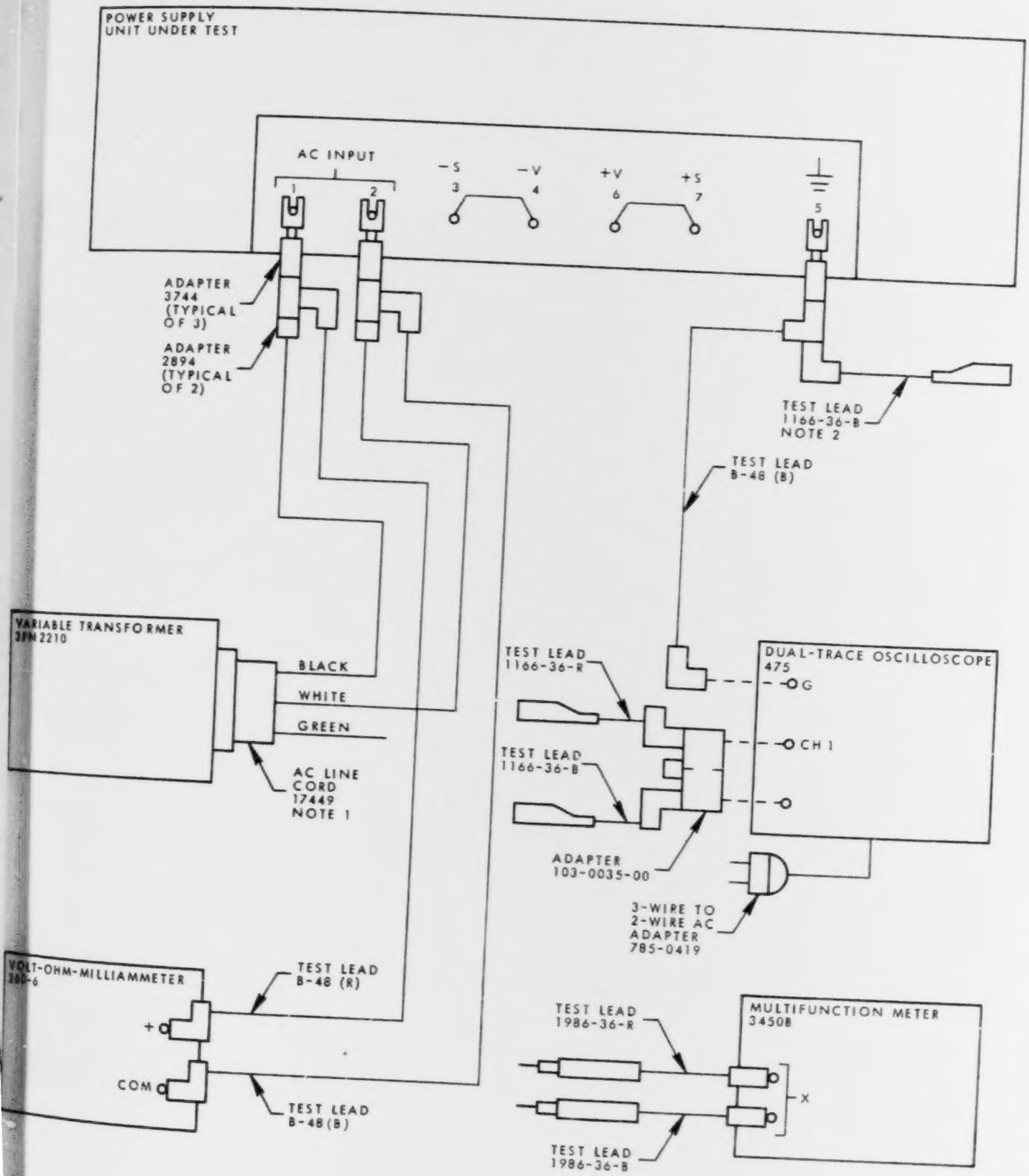

PS2
OVERVOLTAGE PROTECTOR Z1
PS3
OVERVOLTAGE PROTECTOR Z2
PS4
OVERVOLTAGE PROTECTOR Z3
TB1
EL5895-915-34-TM

Figure 3-9. Servo power supply assembly 14A9, parts location (sheet 3 of 3).


POWER SUPPLY
UNIT UNDER TEST
AC INPUT
1
2
−S
3
−V
4
+V
6
+S
7
5
ADAPTER
3744
(TYPICAL
OF 3)
ADAPTER
2894
(TYPICAL
OF 2)
TEST LEAD
1166-36-B
NOTE 2
TEST LEAD
B-48 (B)
VARIABLE TRANSFORMER
3PN 2210
BLACK
WHITE
GREEN
AC LINE
CORD
17449
NOTE 1
TEST LEAD
1166-36-R
TEST LEAD
1166-36-B
DUAL-TRACE OSCILLOSCOPE
475
G
CH 1
ADAPTER
103-0035-00
3-WIRE TO
2-WIRE AC
ADAPTER
785-0419
VOLT-OHM-MILLIAMMETER
260-6
+
COM
TEST LEAD
B-48 (R)
TEST LEAD
B-48 (B)
TEST LEAD
1986-36-R
MULTIFUNCTION METER
3450B
X
TEST LEAD
1986-36-B

NOTES:
1. TAPE BACK GREEN WIRE.
2. CONNECT TO EARTH GROUND.

EL5895-915-34-TM-28

Figure 3-10. Power supply 14A9PS2, A9PS3, A9PS4, troubleshooting and voltage adjustment, test setup diagram.

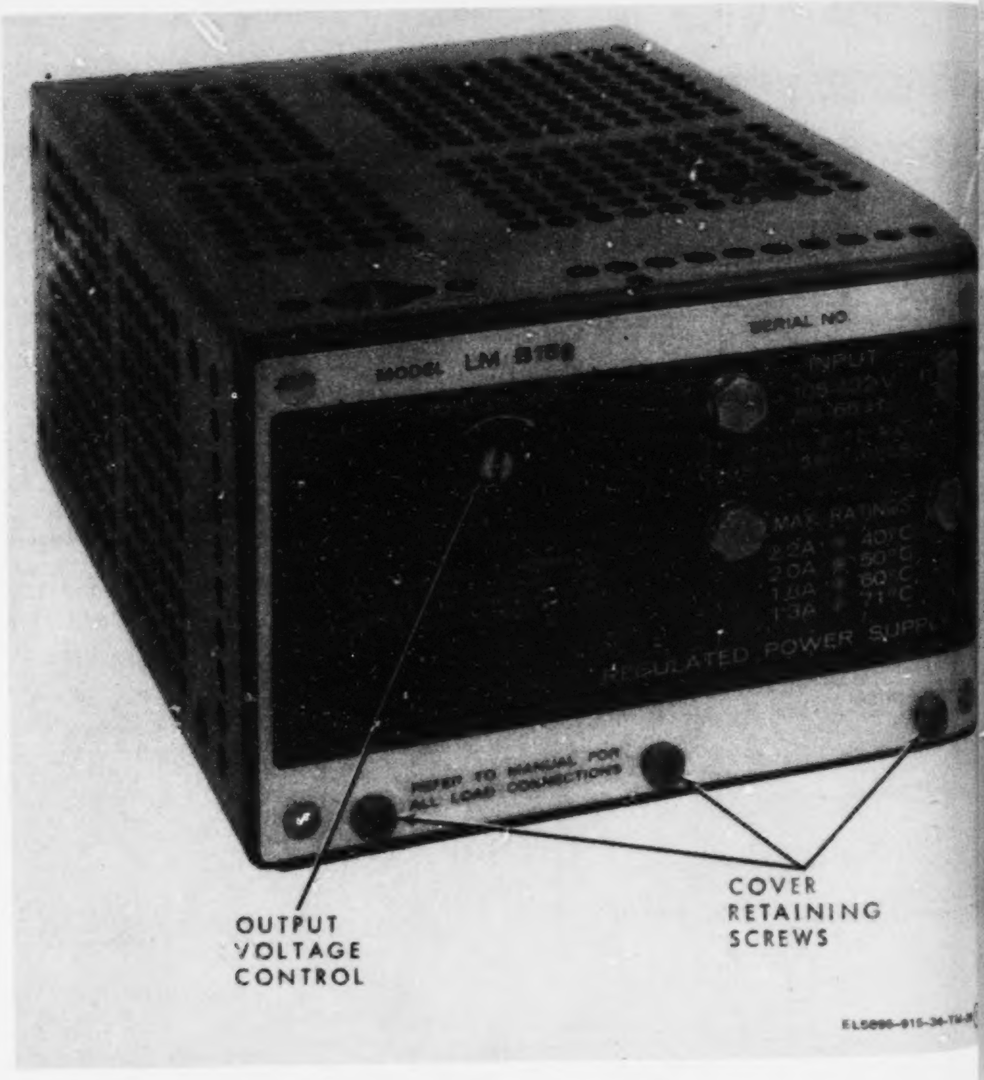

SERIAL NO.
MODEL LM
MAX RATINGS
REGULATED POWER SUPP
REFER TO MANUAL FOR
ALL LOAD CONNECTIONS
OUTPUT
VOLTAGE
CONTROL
COVER
RETAINING
SCREWS
EL5895-915-34-TM-

Figure 3-11. +15 V dc and -15 V dc power supply 14A9PS2, A9PS3, parts location (sheet 1 of 6).

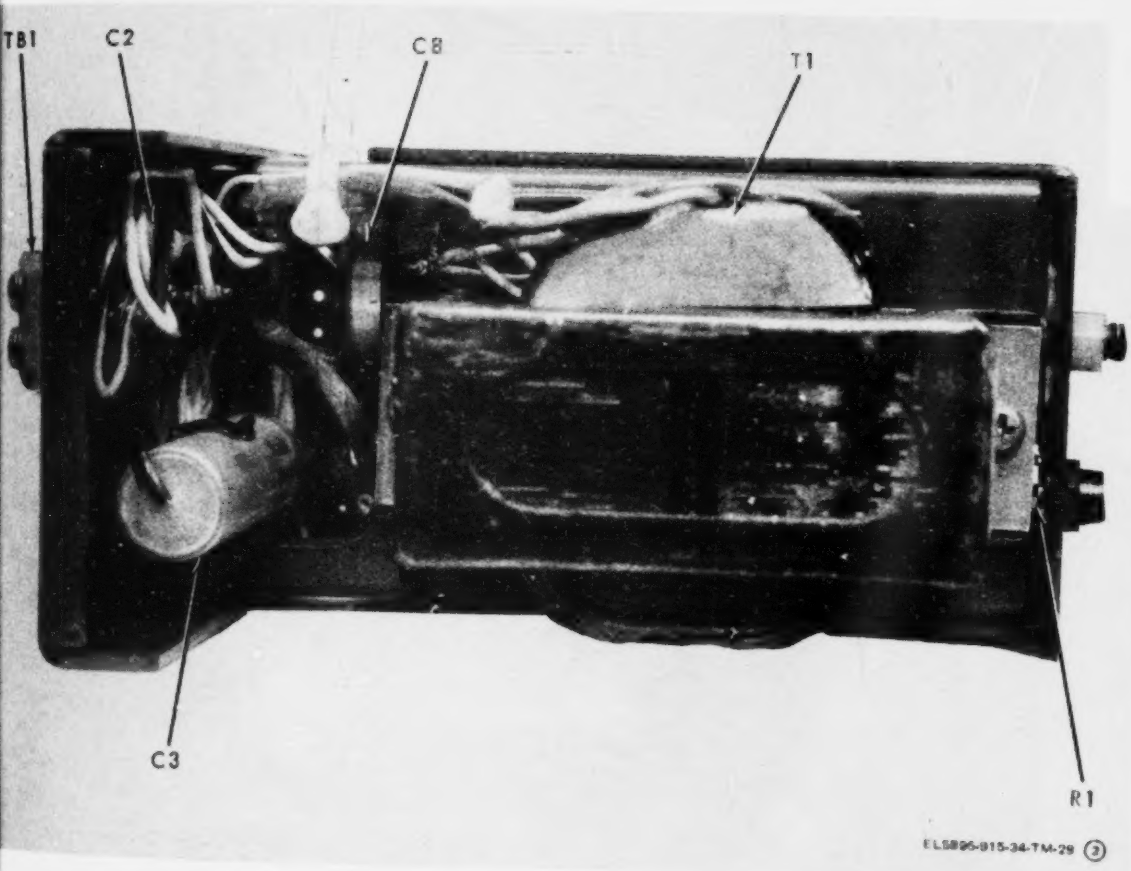
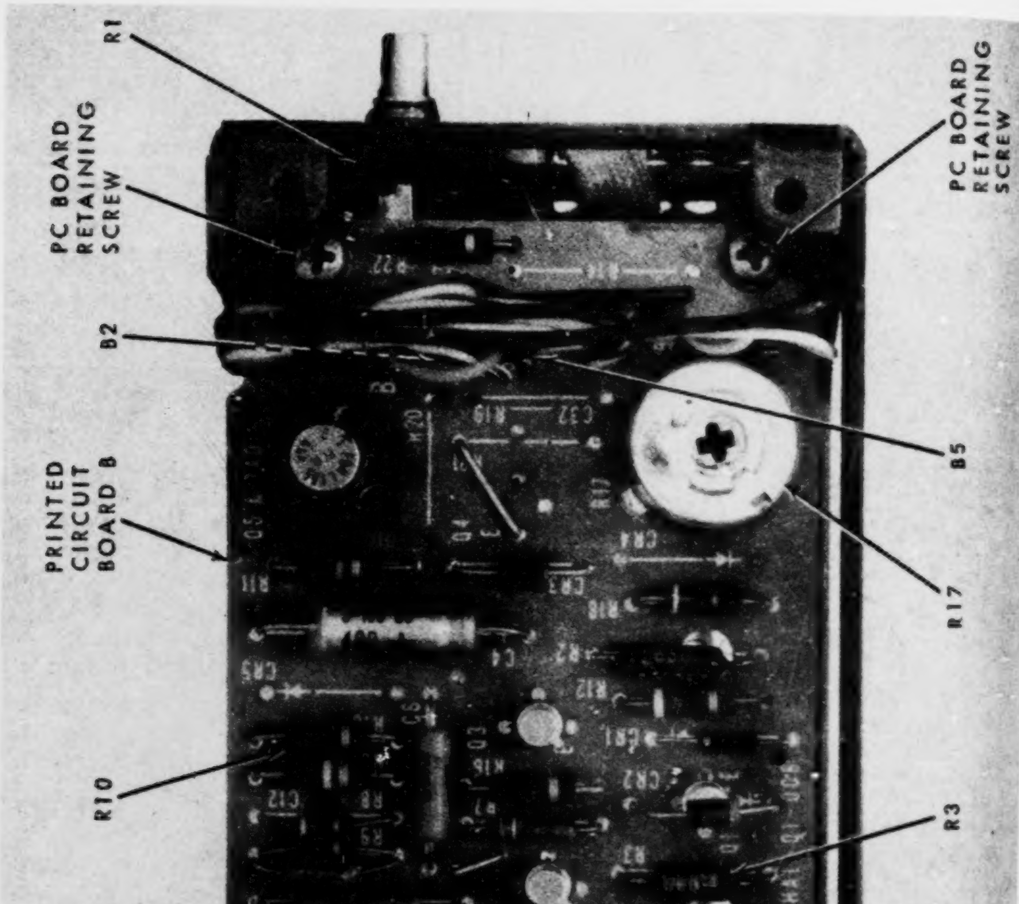

TB1
C2
C8
T1
C3
R1
EL5895-915-34-TM-29 ②

Figure 3-11. +15 V dc and -15 V dc power supply 14A9PS2, A9PS3, parts location (sheet 2 of 6).


R1
PC BOARD RETAINING SCREW
B2
PRINTED CIRCUIT BOARD B
R10
PC BOARD RETAINING SCREW
B13
PC BOARD RETAINING SCREW
B5
R17
R3
B17
PC BOARD RETAINING SCREW
TB1

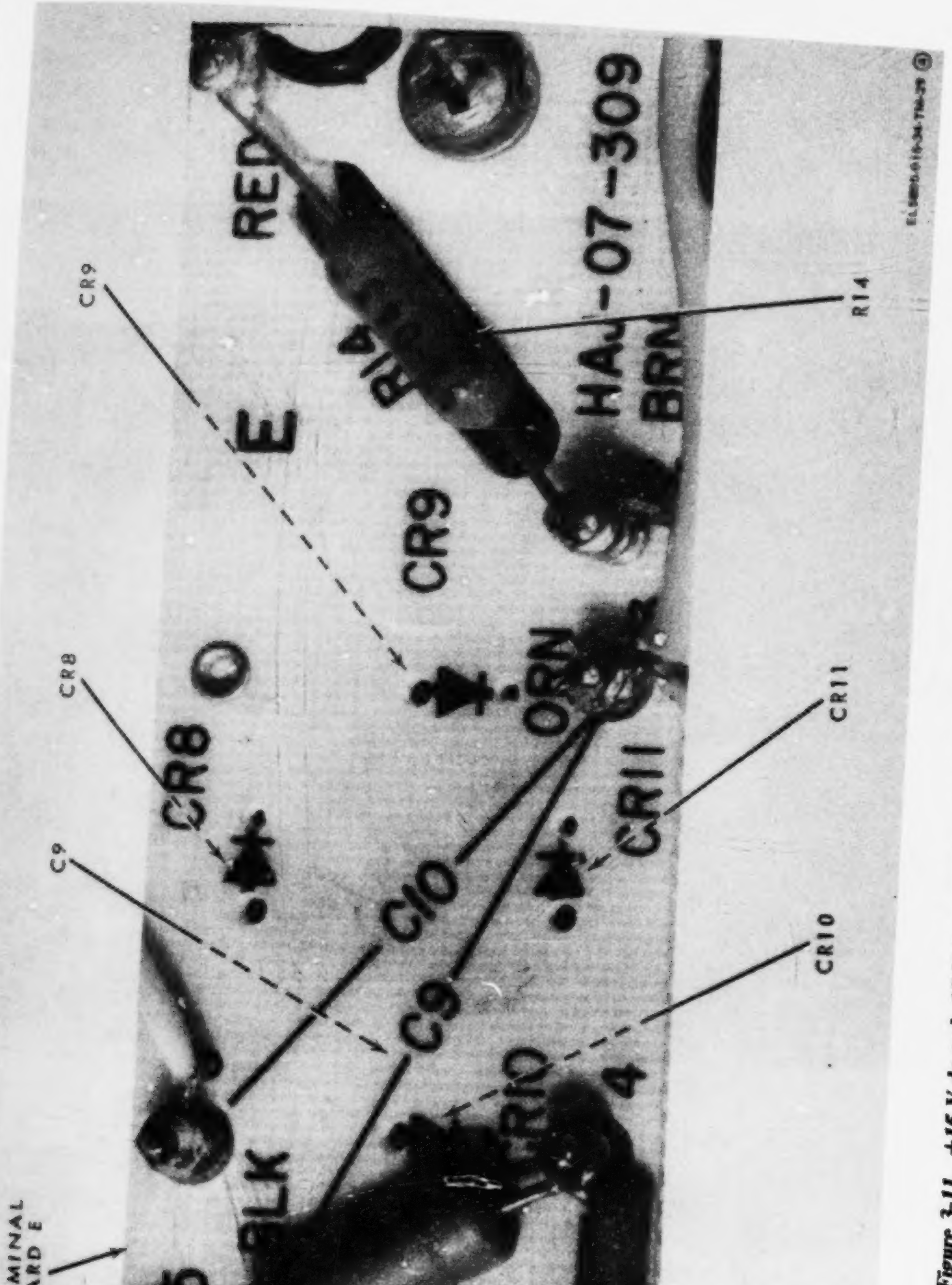
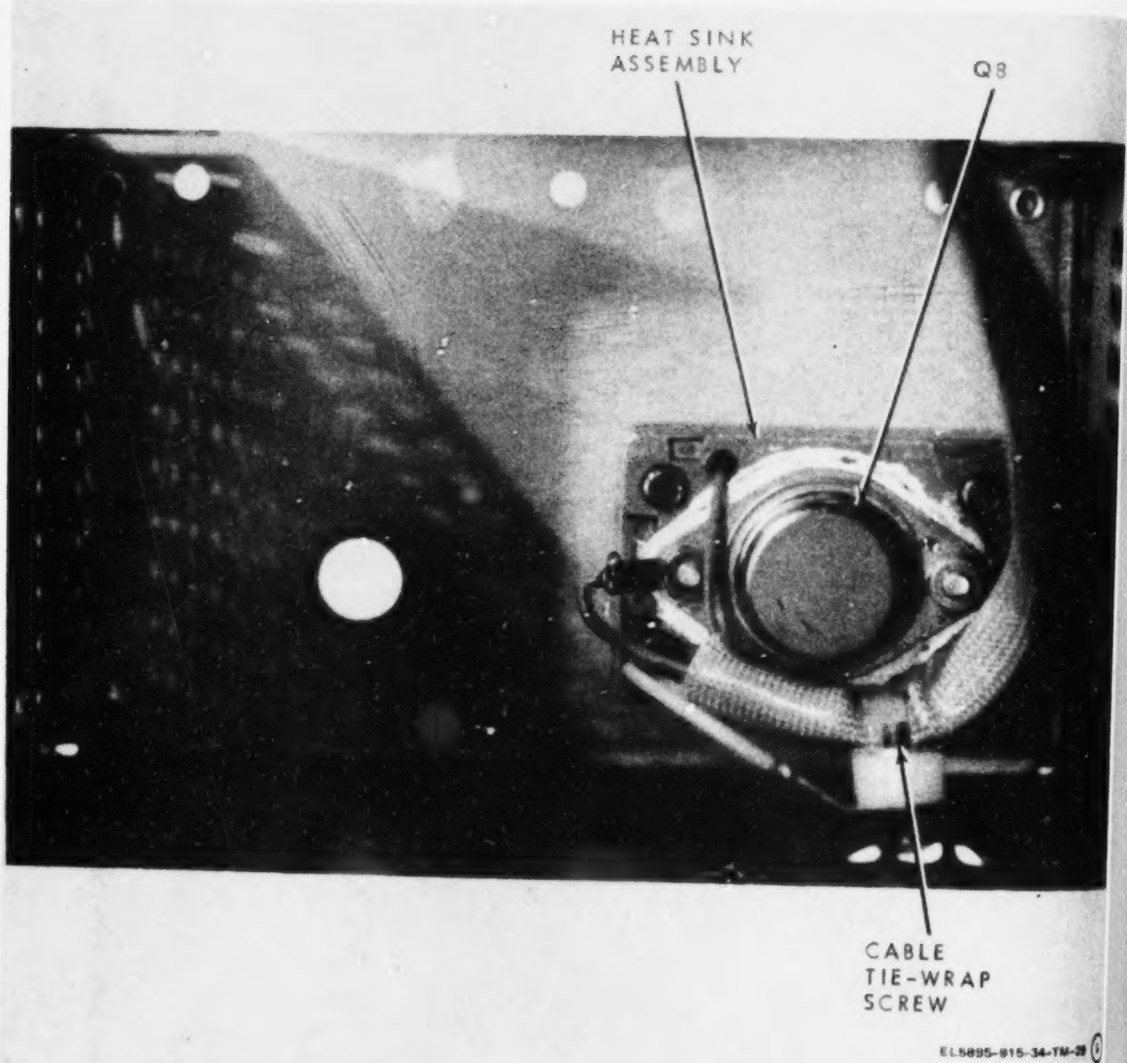

TERMINAL BOARD E
C9
CR8
CR9
C11
CR10
CR11
R14

Figure 3-11. +15 V dc and -15 V dc power supply 14A9PS2, A9PS3, parts location (sheet 4 of 6).


HEAT SINK ASSEMBLY
Q8
CABLE TIE-WRAP SCREW

EL5895-915-34-TM-28 ⑤

Figure 3-11. +15 V dc and -15 V dc power supply 14A9PS2, PS3, parts location (sheet 5 of 6).

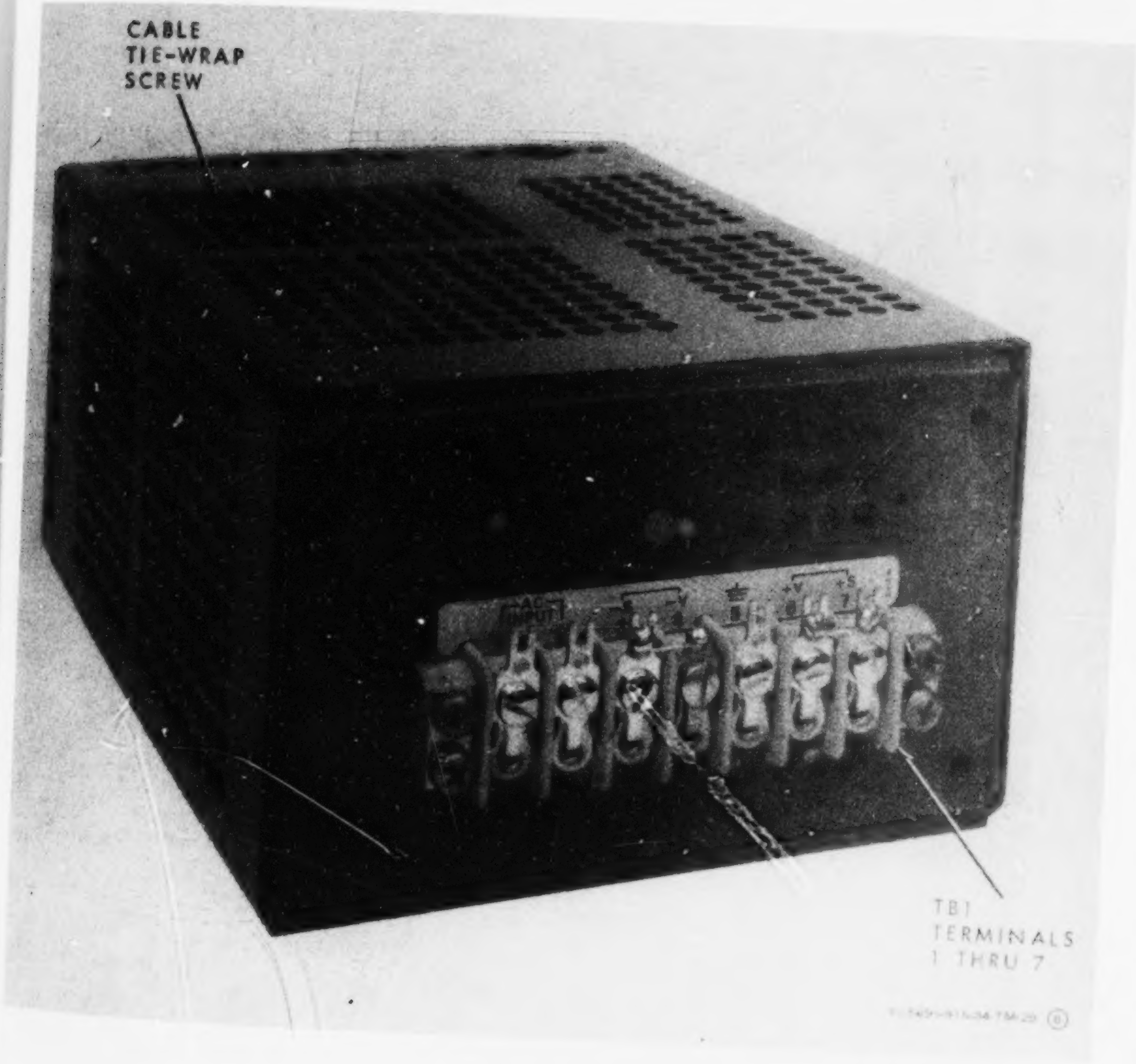

CABLE
TIE-WRAP
SCREW
TB1
TERMINALS
1 THRU 7
11-5895-915-34-TM-29 ⑥

Figure 3-11. +15 V dc and -15 V power supply 14A9PS2, PS3, parts location (sheet 6 of 6).

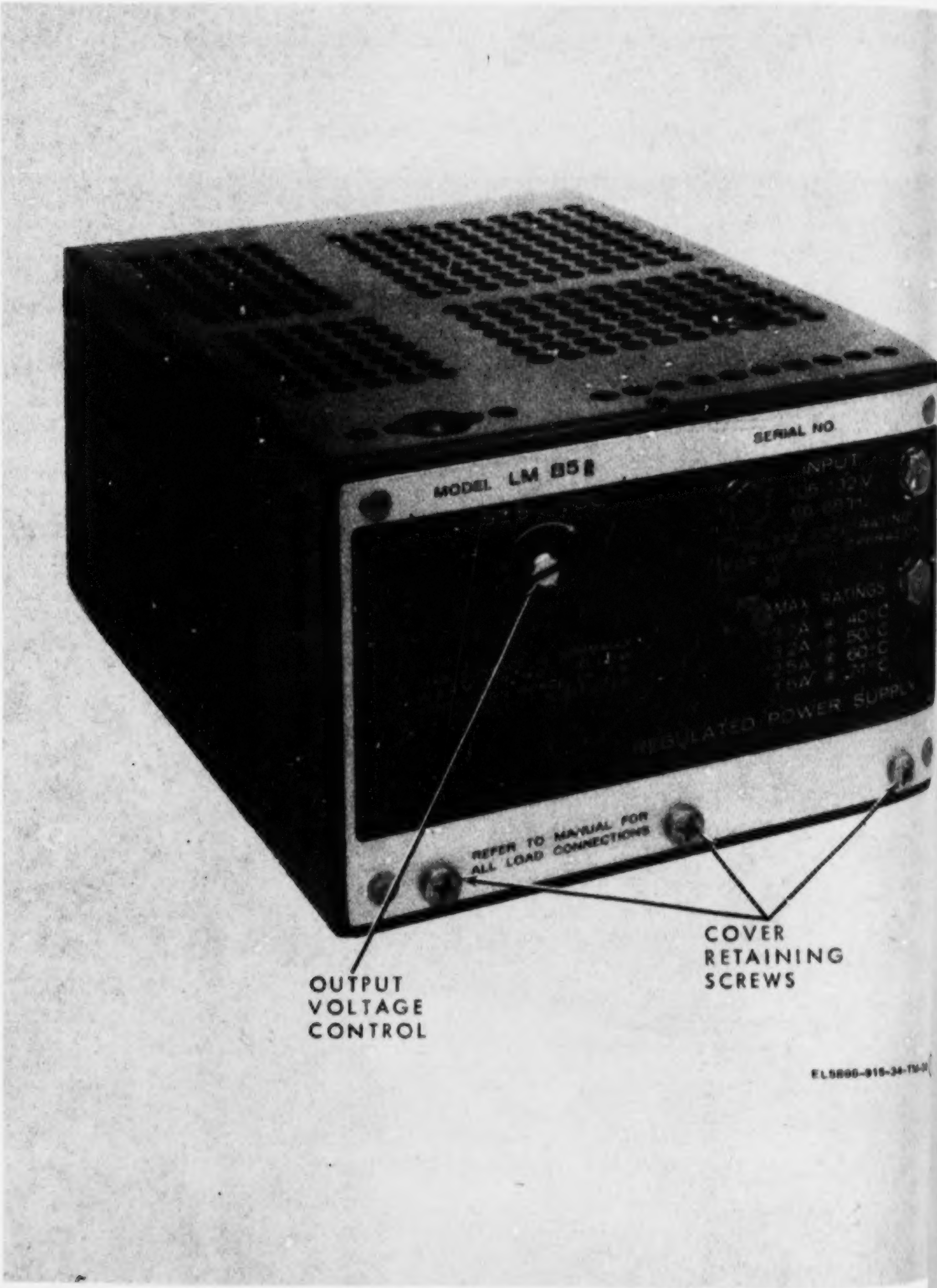

MODEL LM B5
SERIAL NO.
INPUT
MAX RATINGS
REGULATED POWER SUPPLY
REFER TO MANUAL FOR ALL LOAD CONNECTIONS
OUTPUT VOLTAGE CONTROL
COVER RETAINING SCREWS
EL5895-915-34-TM-3

Figure 3-12. +5 V dc power supply 14A9PS4, parts location (sheet 1 of 6).

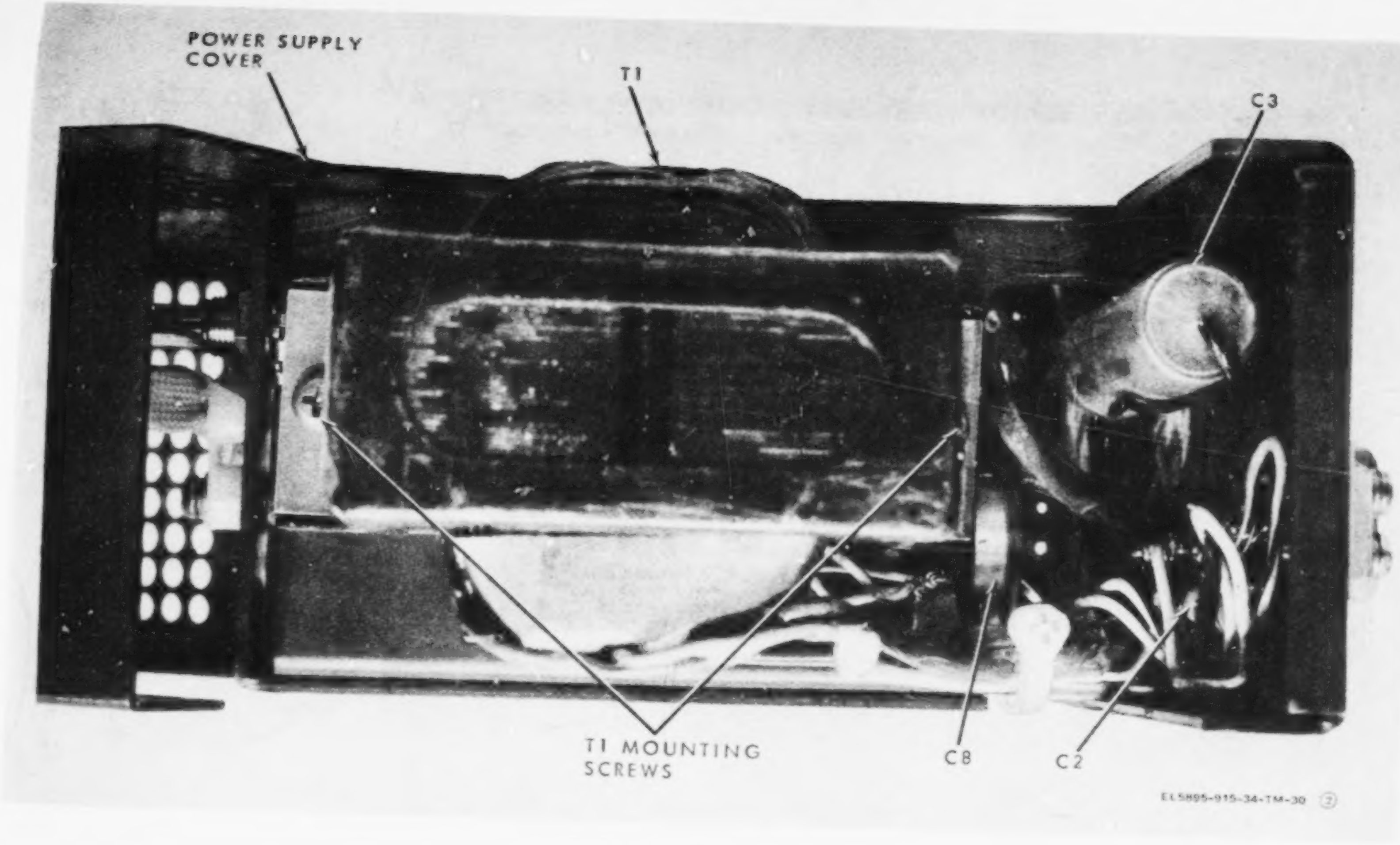

POWER SUPPLY COVER
T1
C3
T1 MOUNTING SCREWS
C8
C2
EL5895-915-34-TM-30 ②

Figure 3-12. +5 V dc power supply 14A9PS4, parts location (sheet 2 of 6).

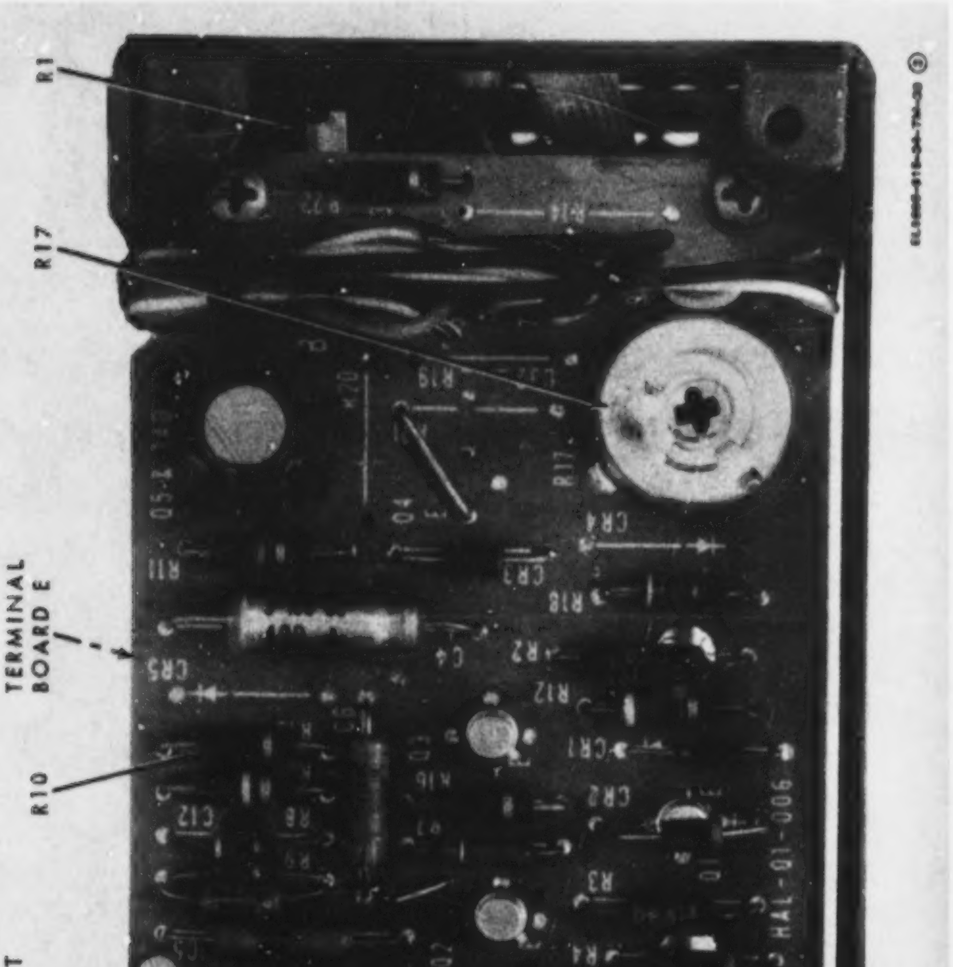

R1
R17
TERMINAL BOARD E
R10
PRINTED CIRCUIT BOARD B
TB1
EL5895-915-34-TM-30

Figure 3-12. 12 V dc Power supply 14A9954, parts location (sheet 3 of 4).

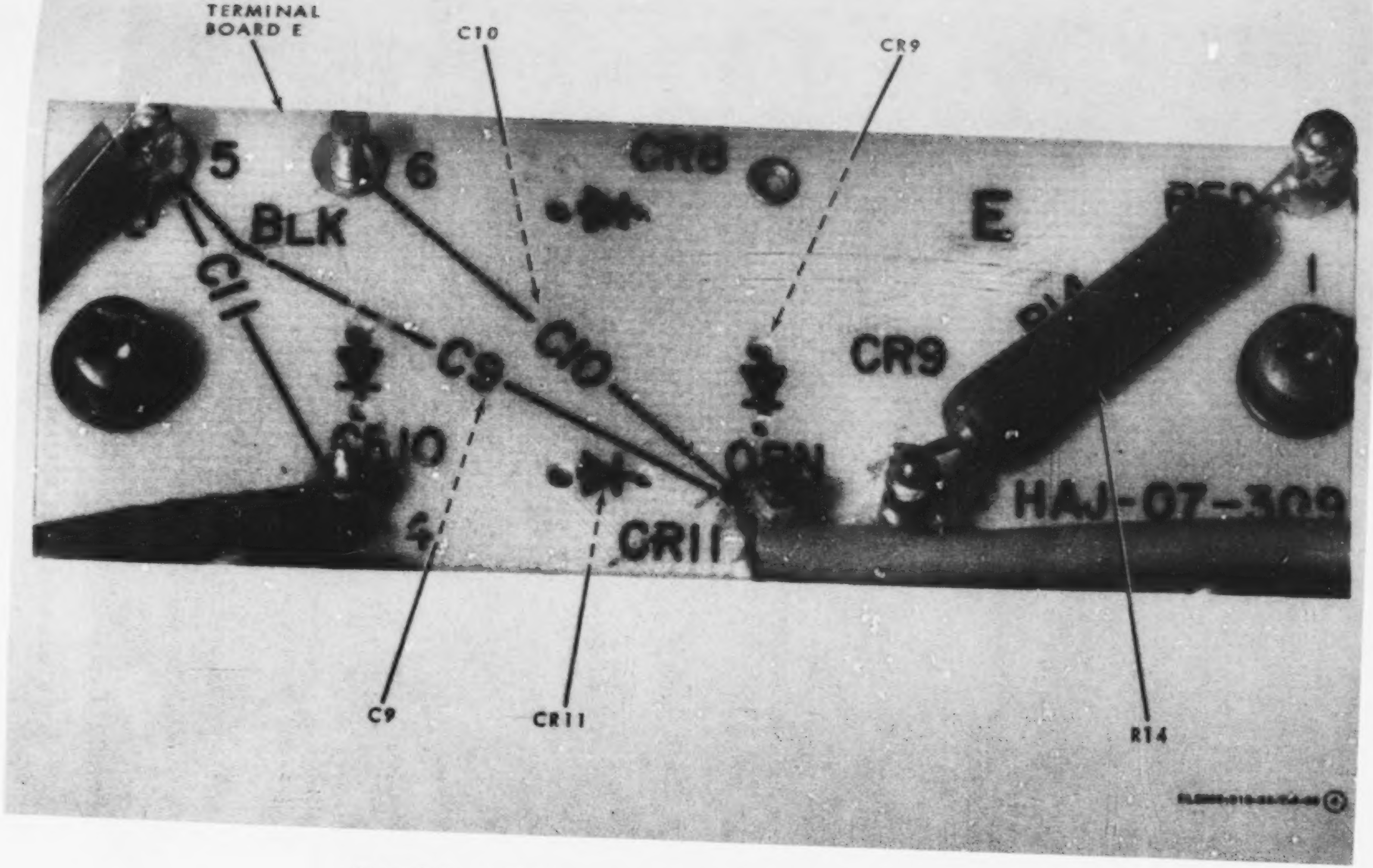
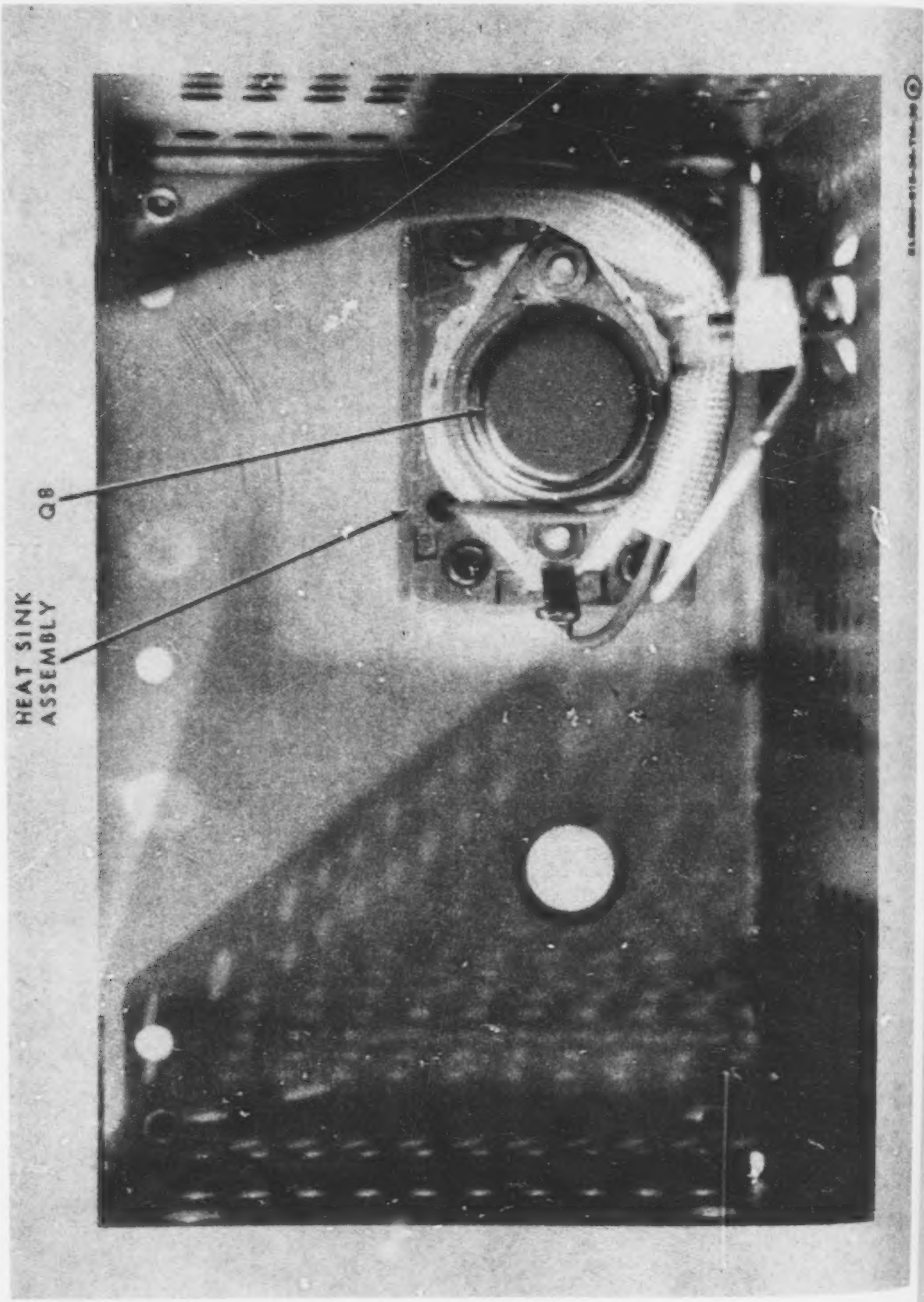

TERMINAL BOARD E
C10
CR9
C9
CR11
R14

Figure 3-12. +5 V dc power supply 14A9PS4, parts location (sheet 4 of 6).


HEAT SINK ASSEMBLY
Q8

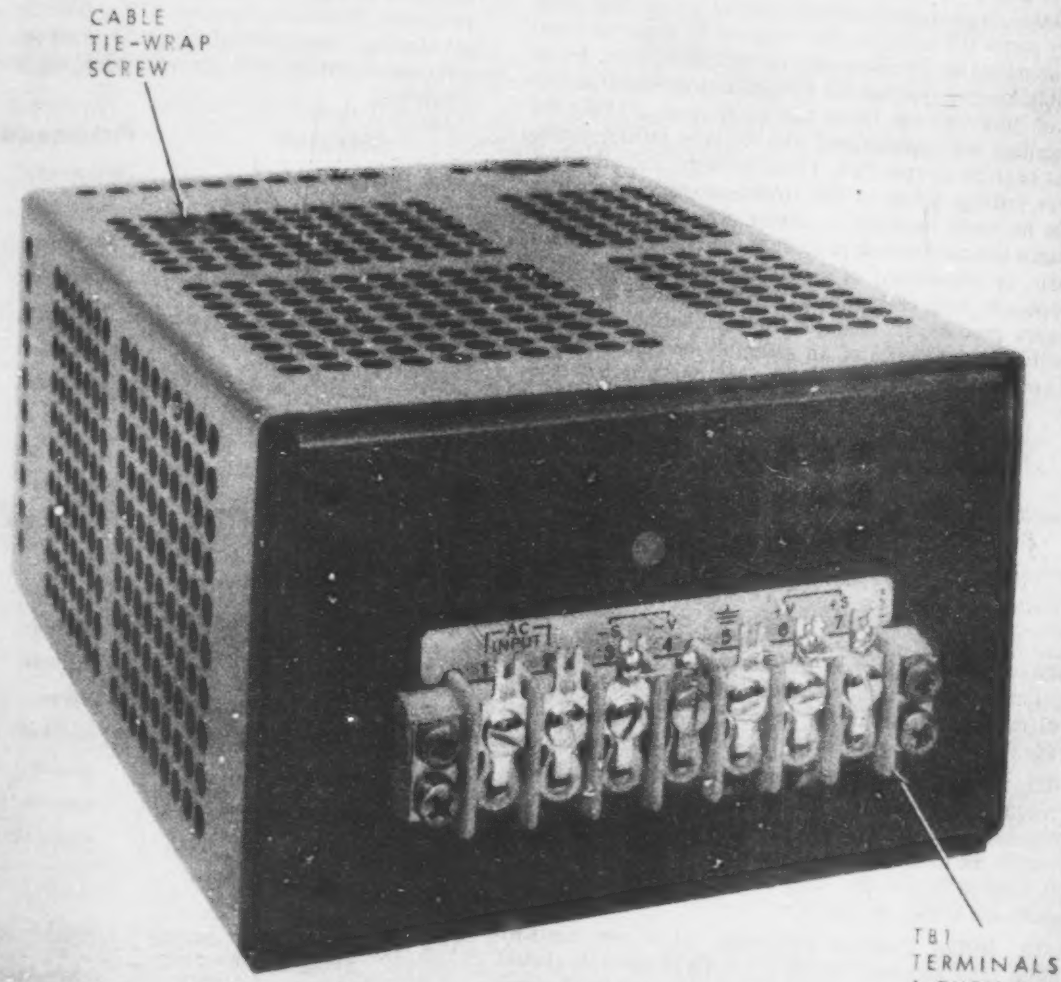

CABLE TIE-WRAP SCREW
AC INPUT
1
2
-S
3
-V
4
5
+V
6
+S
7
TB1 TERMINALS 1 THRU 7
EL5895-915-34-TM-30 ⑥

Figure 3-12. +5 V dc power supply 14A9PS4, parts location (sheet 6 of 6).

SECTION VI. TROUBLESHOOTING OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24

3-27. General. This section contains preliminary procedures and troubleshooting procedures necessary for fault localization to a malfunctioning assembly, subassembly, or module of stow pin control/minor fault summary panel HTA-8A24, after referral by organizational maintenance or by servo and control equipment group troubleshooting (section II). Preliminary procedures consist of obtaining the listed test equipment, making the prescribed test connections, and initially setting equipment controls as specified. These settings, and all subsequent settings given in the troubleshooting procedure, must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement, repair, or adjustment of a malfunctioning assembly or component, refer to section XIV in this chapter for maintenance procedures. When a troubleshooting procedure specifies maintenance of an assembly or component by higher level maintenance, notify the appropriate personnel.

WARNING

Hazardous voltages (120 V ac) are present in stow pin control/minor fault summary panel HTA-8A24. Use caution when performing the following procedures to prevent injury.

3-28. Test Equipment and Materials. The only test equipment required for troubleshooting the stow pin control/minor fault summary panel is a vom 260-6. Test leads required are supplied with the vom.

3-29. Test Connections and Conditions (fig 3-13). Troubleshooting of stow pin control/minor fault summary panel HTA-8A24 is performed with the servo equipment in the local operate mode for both axes. Test points are located behind the front-mounted swing panel. Test points are shown on figure 3-13.

3-30. Initial Control Settings. Stow pin control/minor fault summary panel HTA-8A24 controls should be set for online system operation and should be changed only as necessary for fault isolation. Set OPERATE switches on both electronic control amplifiers HTA-9A2,9A3 to LOCAL, and set LOCAL switches to OFF. Use the LOCAL switches and SLEW control to operate the antenna in the following procedures. Set vom function switch to AC and range switch to 250 V.

3-31. Troubleshooting Procedures. After completing the preliminary procedures, perform the necessary troubleshooting procedures in table 3-11 as specified by the symptom/probable cause listing below. The stow pin control/minor fault summary panel HTA-8A24 schematic (fig. F0-16) will assist in performing the tr shooting procedures. Refer to figure 3-14 for location. After the faulty item has been replaced, pe the servo and control equipment group performanc procedure described in section XIX of this chapter. satisfactory completion of the performance test, the pin control/minor fault summary panel can be ret to service.

Symptom	Probable cause
STOW indicator on antenna position and status panel is lit (red).	Faulty stow pin control or status relay. Refer to table 3-11, step 4.
MINOR DRIVE FAULT indicator on antenna position and status panel is lit (amber).	Faulty minor drive fault status relay or minor drive fault relay chain. Refer to step 8.
MINOR DRIVE FAULT indicator on antenna position and status panel is out, but a minor fault is sensed by external equipment.	Faulty minor fault summary status relay or minor fault summary relay chain. Refer to step 10
Operator unable to turn on rain deflector.	Faulty switch S5. Refer to step 9.
Operator unable to select antenna minor maintenance.	Faulty switch S6. Refer to step 3.
Operator unable to stow	Faulty switch S1 or relay K8.

Symptom	Probable cause
antenna in aximuth axis.	Refer to step 4.
Operator unable to stow antenna in elevation axis.	Faulty switch S3 or relay K12.. Refer to step 6.
Operator unable to retract aximuth stow pin.	Faulty switch S2 or or relay K9. Refer to step 5.
Operator unable to retract elevation stow pin.	Faulty switch S4 or relay K13. Refer to step 7.
External minor fault summary fault status, and minor maintenance sensed; MINOR DRIVE FAULT AND STOW indicators on antenna position and status panel are lit.	Faulty circuit breaker CB1 or +26 V dc power supply PS1 circuit. Refer to steps 1 and 2.

Table 3-11 Stow Pin Control/Minor Fault Summary Panel HTA-8A24 Troubleshooting Procedure

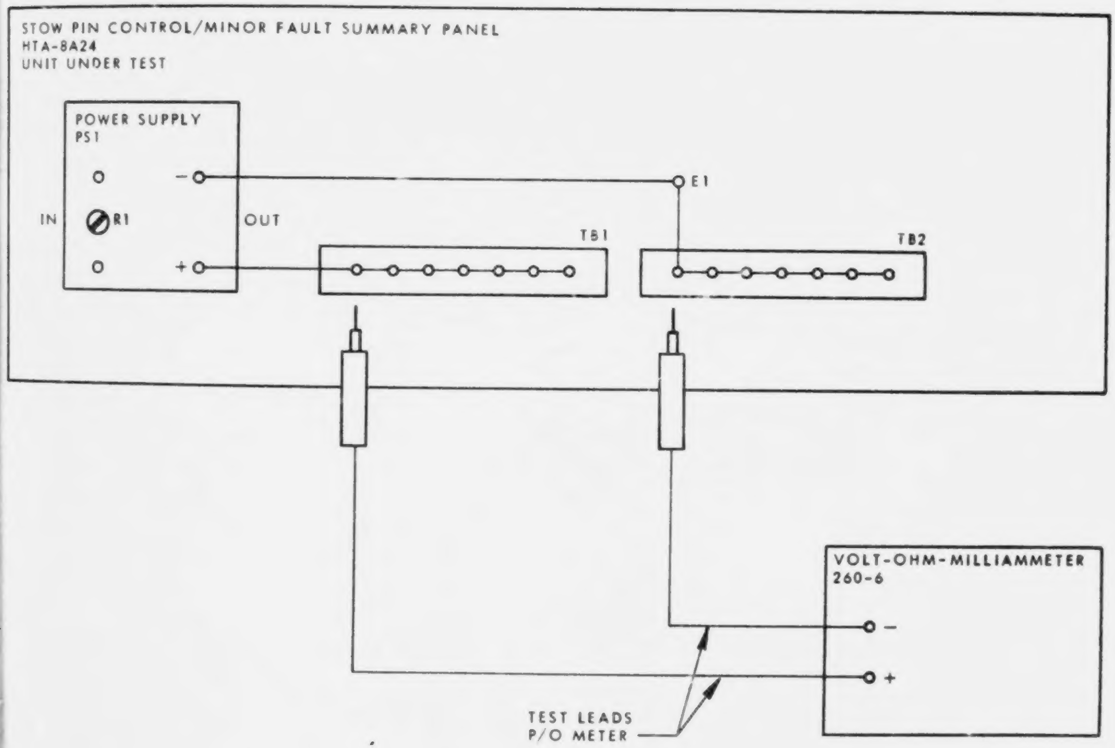
Steps	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Power switch CB1	Operational configuration	Connect vom to power supply input.	120 ±12 V ac	If indication is abnormal and CB7 in distribution box HTA-8A25 is not tripped, replace CB1 (section XIV).
2	+26 V dc power supply PS1	Power switch CB1 is set to ON; vom is set for 50 V DC.	Connect vom (+) lead to TB1 and (-) lead to TB2.	+26 ±2.6 V dc	If voltage indication is 0, replace PS1; if indication is out of tolerance, adjust power supply for +26 V dc output (section XIV).
3	MAINTENANCE switch S6	Indicator switch is pressed to maintenance mode.		Indicator switch lights (blue).	If indicator is abnormal, replace S6 (section XIV).
4	AZIMUTH STOW indicator switch S1 and relay K8	AZIMUTH RETRACT switch S2 is lit (green); STOW indicator switch S1 is pressed and held.		RETRACT indicator goes out; AZIMUTH IN TRANSIT indicator lights (white), remains lit for approximately 15 seconds, then goes out; and STOW indicator lights (amber).	If AZIMUTH STOW indicator lights but IN TRANSIT indicator does not go out, replace K8; if neither IN TRANSIT or STOW lights, replace S1 (section XIV).
	AZIMUTH RETRACT indicator switch S2 and relay K9	AZIMUTH STOW indicator switch S1 is lit (amber); RETRACT indicator switch S2 is pressed.		STOW indicator goes out; AZIMUTH IN TRANSMIT indicator lights (white), remains lit for approximately 15 seconds, then goes out; and RETRACT indica-	If AZIMUTH RETRACT indicator lights but IN TRANSIT indicator does not go out, re place K9; if neither IN TRANSIT

Table 3-11 Stow Pin Control/Minor Fault Summary Panel HTA-8A24 Troubleshooting Procedure - Continued

Steps	Item of check	Test conditions	Test connections	Normal indication	Additional chec and remark
				tor lights (green).	or RETRACT ind tor lights, replace S (section XIV).
6	ELEVATION STOW indicator switch S3 and relay K12	ELEVATION RETRACT indicator switch S4 is lit (green); STOW indicator switch S3 is pressed.		RETRACT indicator goes out; ELEVATION IN TRANSIT indicator lights (white), remains lit for approximately 15 seconds, then goes out; and STOW indicator lights (amber).	If ELEVATION ST indicator lights bu TRANSIT indica does not go out, r place K12; if neit IN TRANSIT or STOW indicator lights, replace S3 tion XIV).
7	ELEVATION RETRACT indicator switch S4 and relay K13	ELEVATION STOW indicator switch S3 is lit (green); RETRACT indicator switch S4 is pressed.		STOW indicator goes out; ELEVATION IN TRANSIT indicator lights (white), remains lit for approximately 15 seconds, then goes out; and RETRACT indicator lights (amber).	If ELEVATION RE TRACT indicator lights but IN TRA SIT indicator do go out, replace K neither IN TRAN nor STOW indica lights, replace S4 tion XIV).
8	Minor drive fault relay chain K10, K1, K2, K6, K7, K3, K14, and K15	Director current control is in LOCAL OPERATE mode.		AZ NO.1 LUBE OIL indicator DS1, AZ NO.2 LUBE OIL indicator DS2, EL No.1 LUBE OIL indicator DS6, EL NO.2 LUBE OIL indicator DS7, SCR FUSES indicator DS3, and EL SCR FUSES indicator DS8 are out.	If minor drive fault incated at antenn sition and status and DS1 is lit, rep K1; if DS2 is lit, place K2; if DS6 replace K6; if DS lit, replace K7; is lit, replace K3 DS8 is lit, replac K14; if none of th above are lit, chec for 26 V dc on ca thode side of CR (at E3). sent, rep K10, if not, replac CR16. If a fault dicated at end of operating sequen but no fault indic is lit, replace K1 section XIV.)
9	RAIN DEF ON indicator switch	Indicator switch S5 is pressed to operate state; vom is set for 50 V dc.	a. Connect vom (+) lead to S5-1NO and (-) lead to TB2. b. Connect vom (+) lead to indicator section of S5 and (-) lead to TB2.	a. +26 ±2.6 V dc b. +26 ±2.6 V dc	a. If indication is a mal, replace S5 tion XIV). b. If indication is a mal, replace indic section of S5 (sec XIV).

Table 3-11 Stow Pin Control/Minor Fault Summary Panel HTA-8A24 Troubleshooting Procedure - Continued

Steps	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
10	Minor fault relay chain K11, K5, and K4			AIR COND/XMT FLTR indicator DS5 and NITROGEN PRESSURE indicator DS4 are out; no minor drive fault is indicated (26 V dc at pins 6(+) and 4 of relay K10)	If DS5 is lit, replace K5; if DS4 is lit, replace K4; if neither DS5 nor DS4 is lit and no minor drive fault is indicated, replace K11 (section XIV).


STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL
HTA-8A24
UNIT UNDER TEST
POWER SUPPLY
PS1
IN
R1
OUT
−
+
E1
TB1
TB2
VOLT-OHM-MILLIAMMETER
260-6
−
+
TEST LEADS
P/O METER

EL5895-915-34-TM-31

Figure 3-13. Stow pin control/minor fault summary panel HTA-8A24, troubleshooting, test setup diagram

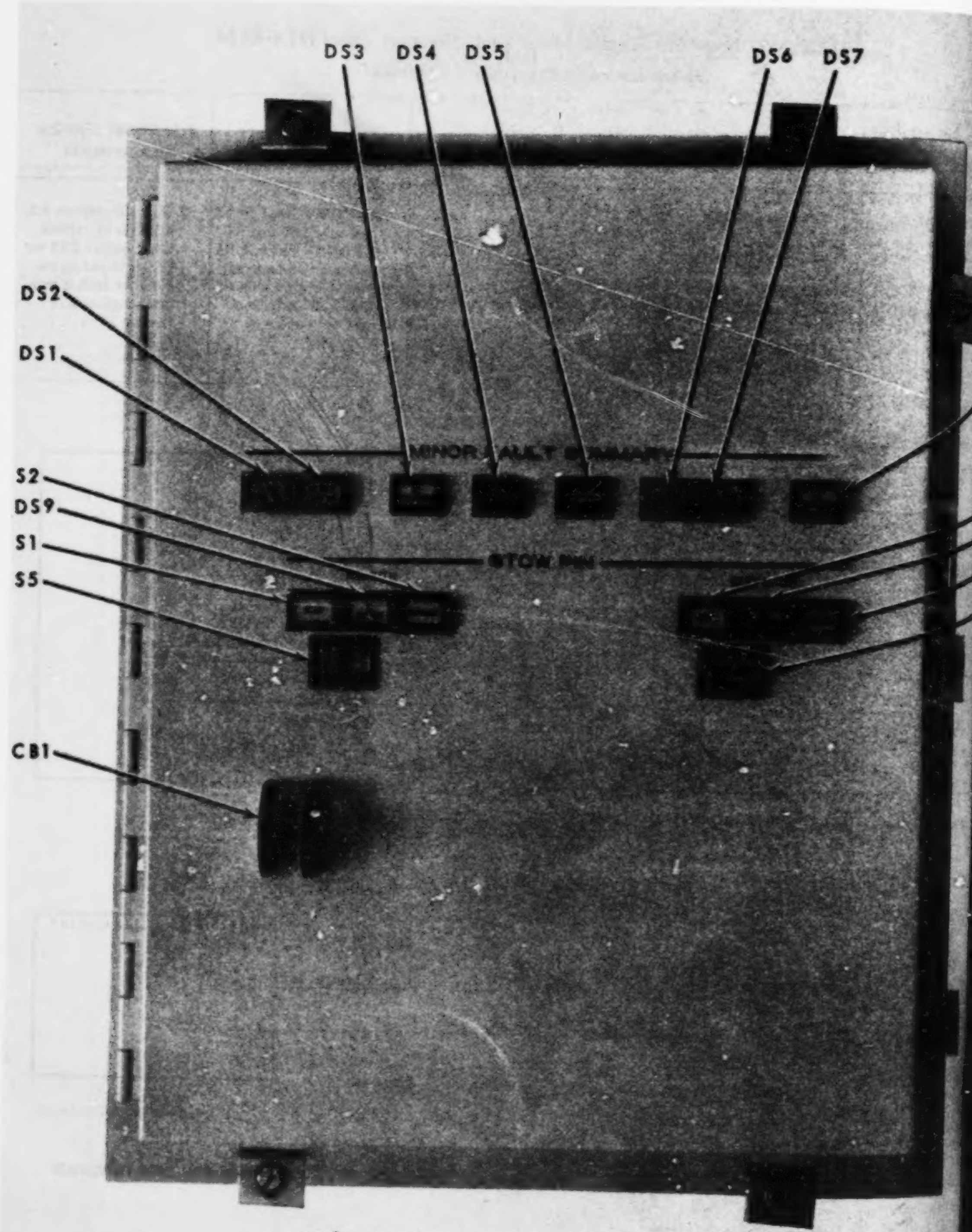

DS3
DS4
DS5
DS6
DS7
DS2
DS1
S2
DS9
S1
S5
CB1
MINOR FAULT SUMMARY
STOW PIN
FRONT VIEW, SWING PANEL CLOSED

Figure 3-14. Stow pin control/minor fault summary panel HTA-8A24, parts location (sheet 1 of 3).

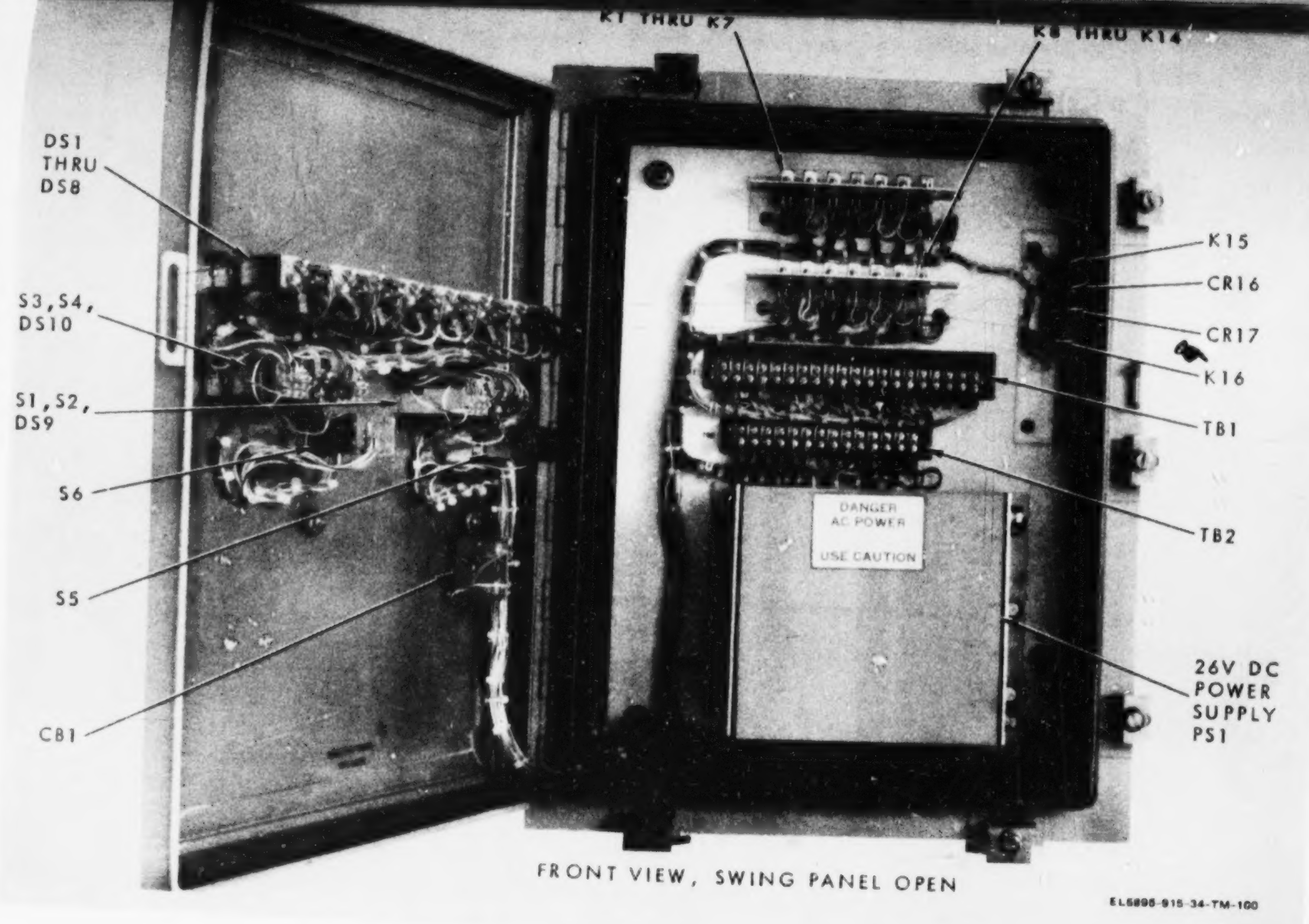

K1 THRU K7
K8 THRU K14
K15
CR16
CR17
K16
TB1
TB2
26V DC POWER SUPPLY PS1
DS1 THRU DS8
S3, S4, DS10
S1, S2, DS9
S6
S5
CB1
DANGER AC POWER USE CAUTION
FRONT VIEW, SWING PANEL OPEN
EL5895-915-34-TM-100

Figure 3-14. Stow pin control/minor fault summary panel HTA-8A24, parts location (sheet 2 of 3).

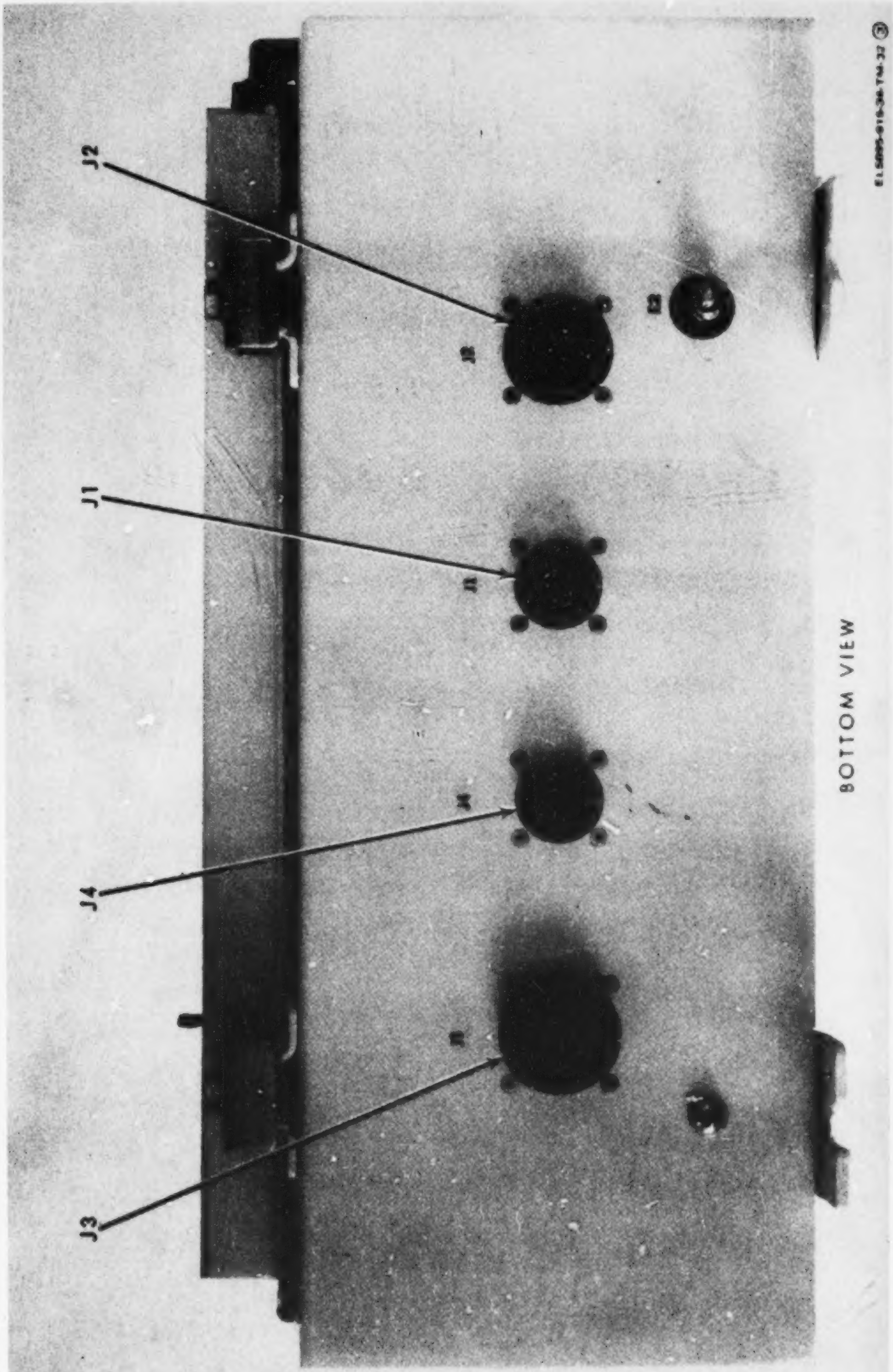

J2
J1
J4
J3
BOTTOM VIEW
EL5895-915-34-TM-32

Figure 3-14. Stow pin control/minor fault summary panel HTA-8A24, parts location (sheet 3 of 3).

SECTION VII. TROUBLESHOOTING OF DIRECT CURRENT CONTROL HTA-9

3-32. General. This section contains the basic troubleshooting procedures necessary to isolate a fault to a cabinet-mounted component or to a subassembly of direct current control HTA-9 after referral by organizational maintenance or by the servo and control equipment group test (section II). This section also contains the procedures necessary to troubleshoot each of the subassemblies. Cabinet-mounted components consist of: four power inductors, L1 through L4; two magnetic contactors, K1 and K2; power-on flashers DS1 and DS2; cabinet fan B1; and door interlock switch S1. The subassemblies are power supply control A1 and two electronic control amplifiers, A2 and A3. When a fault is isolated to one of the three subassemblies, a reference is made to the applicable troubleshooting paragraph. Each subassembly troubleshooting paragraph contains the necessary procedures to isolate a fault to a component or circuit card. The basic troubleshooting procedures are performed with the equipment on line. When a troubleshooting procedure specifies replacement, repair, or adjustment of a malfunctioning assembly or component, refer to section XV in this chapter for the maintenance procedure. When a troubleshooting procedure specifies maintenance of an assembly or component by higher level maintenance, notify the appropriate personnel.

3-33. Direct Current control HTA-9 Basic Troubleshooting. This paragraph provides the instructions and procedures to isolate a malfunction to a major subassembly or cabinet-mounted component of direct current control HTA-9.

a. Test Equipment and Materials. The only test equipment required for basic troubleshooting of direct current control HTA-9 is a dual-trace oscilloscope 475 and a vom 260-6. Test leads required are supplied with the test equipment. All of the test equipment may not be needed for isolation of a fault. For example, only the vom may be required for voltage or continuity checks for a power or a switching fault. Therefore, the test equipment should be selected after review of the symptom/probable cause listing and the step referenced in the troubleshooting table.

b. Test Connections and Conditions (fig. 3-15, 3-16, 3-17, and 3-18). Troubleshooting of direct current ntrol HTA-9 is performed with servo equipment in the erational configuration and the direct current control the local slew mode. LED indicators on electronic conol amplifiers A2 and A3 (fig. 3-15) are used for localiz- faults to A1, A2, or A3, or to a cabinet-mounted mponent (fig. 3-18). The test setup diagram, figure 16, will assist in isolating a fault to a cabinet-mounted gnetic contactor or power inductor. Test points (TP) uired for further isolation are shown on figure 3-17.

WARNING

When required to perform tests or repairs within the direct current control cabinet, use extreme care to avoid injury or death from high voltages (277/480 V ac).

c. Initial Control Settings. The servo and control equipment, except direct current control HTA-9, should be set for online system operation and should be changed only as necessary for fault isolation. Initial control settings for all test equipment that may be used in troubleshooting are listed in the following subparagraphs. Once the test equipment has been selected as described in paragraph 3-33*a*, prepare the test equipment and azimuth or elevation control amplifier circuit card assembly as described in the following subparagraphs.

Control	**Position**
Oscilloscope	
VERT MODE	CH 1
CH 1 and CH 2 VOLTS/DIV	As required to observe signal
CH 1 and CH 2 AC-GND-DC	DC
HORIZ DISPLAY	A-LOCK KNOBS
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER-SLOPE AND LEVEL	As required for stable display
TRIGGER HOLDOFF	NORM
10X MAG	OFF (out)
VOM	
Range	Rx1
Function	DC

CAUTION

The antenna may drift in the azimuth or elevation axis when the LOCAL switch on either electronic control amplifier is set to SLEW. Maintain control at all times to prevent antenna drift into an electrical limit.

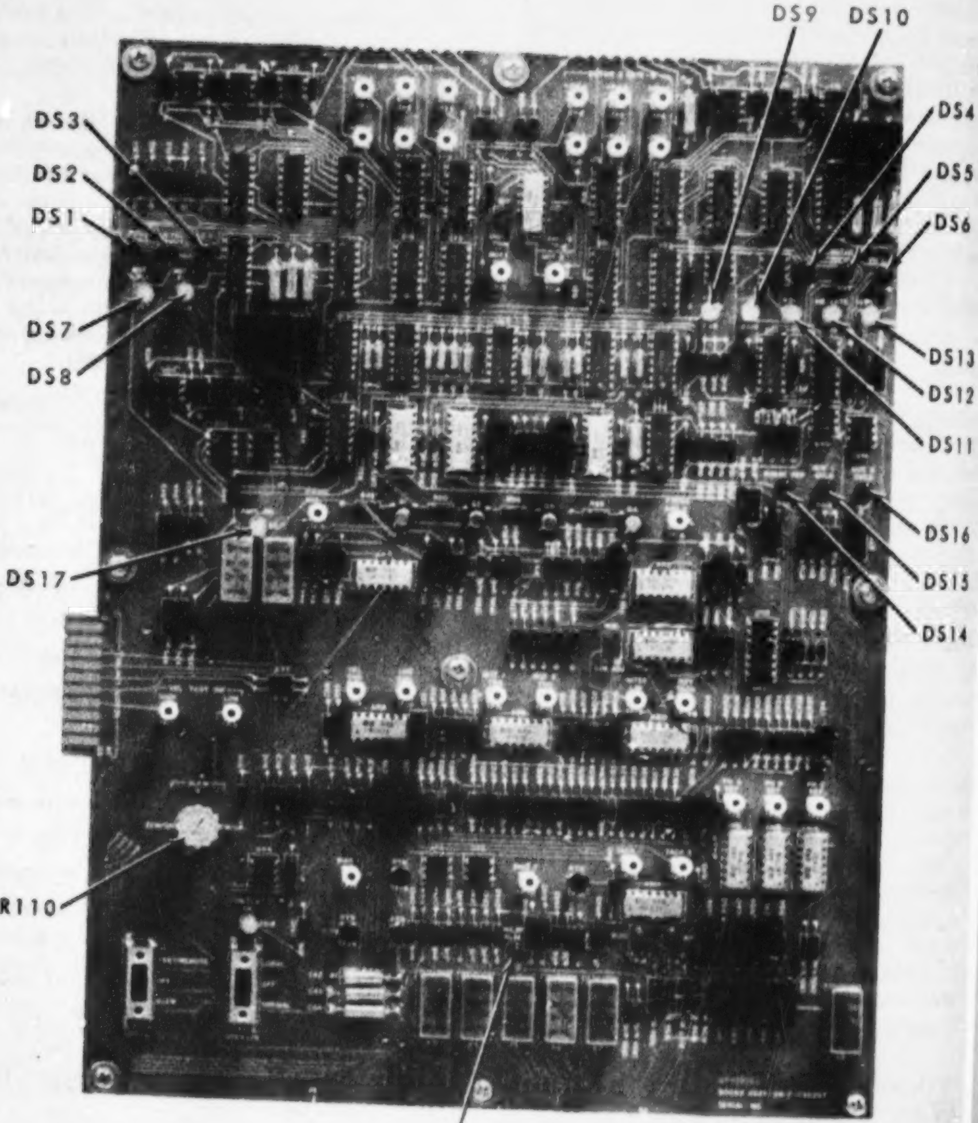
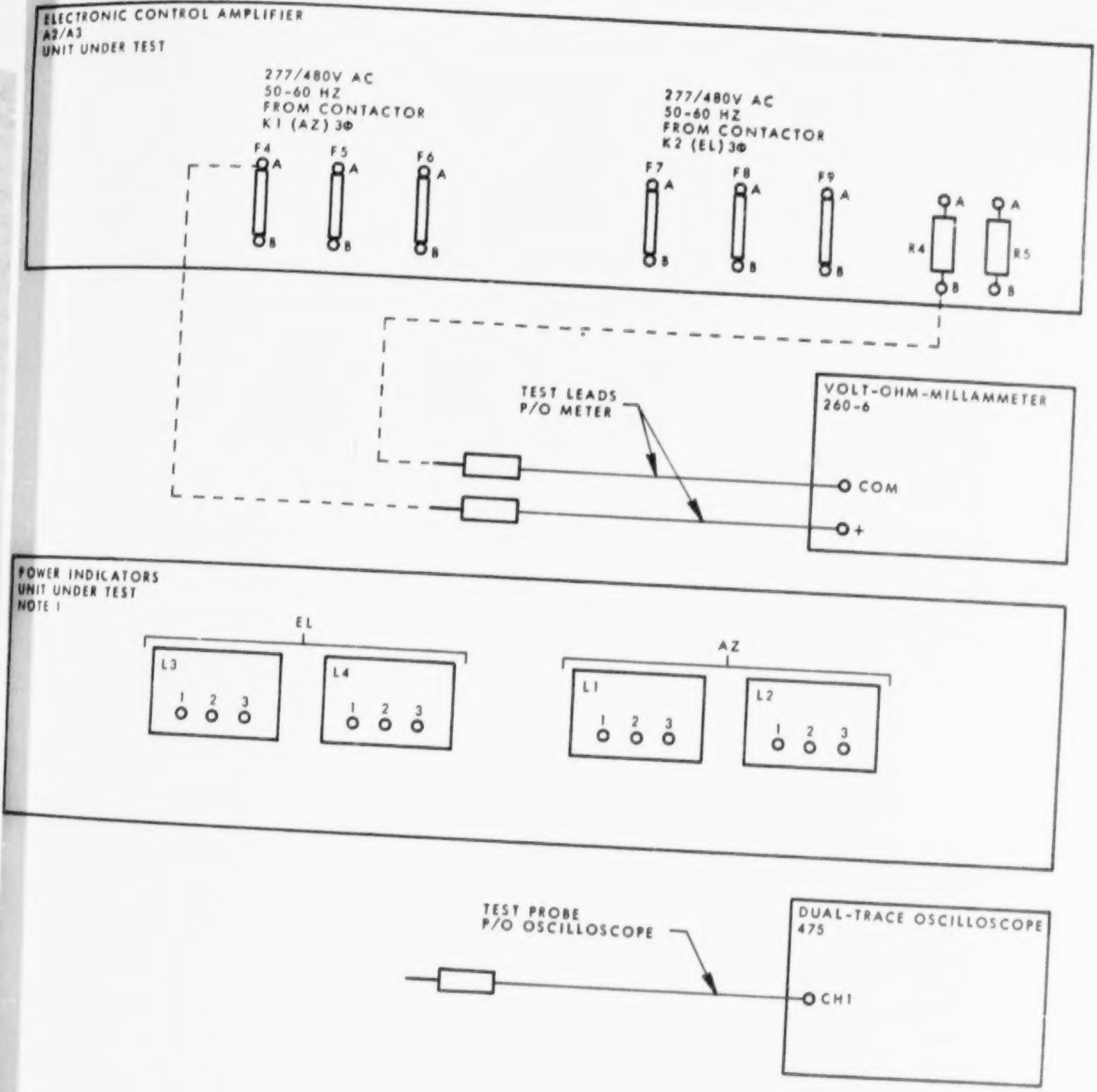

DS9
DS10
DS3
DS4
DS2
DS5
DS1
DS6
DS7
DS8
DS13
DS12
DS11
DS16
DS17
DS15
DS14
R110
DS19
EL5895-915-34-TM-33

Figure 3-15. LED indicator locations on circuit card assembly HTA-9A2A1, 9A3A1.


ELECTRONIC CONTROL AMPLIFIER
A2/A3
UNIT UNDER TEST
277/480V AC
50-60 HZ
FROM CONTACTOR
K1 (AZ) 3Φ
277/480V AC
50-60 HZ
FROM CONTACTOR
K2 (EL) 3Φ
F4
F5
F6
F7
F8
F9
A
B
R4
R5
TEST LEADS
P/O METER
VOLT-OHM-MILLAMMETER
260-6
COM
+
POWER INDICATORS
UNIT UNDER TEST
NOTE 1
EL
AZ
L3
L4
L1
L2
1
2
3
TEST PROBE
P/O OSCILLOSCOPE
DUAL-TRACE OSCILLOSCOPE
475
CH1

NOTES:

1. REAR DOOR ACCESS.

EL5985-915-34-TM-34

Figure 3-16. Direct current control HTA-9, troubleshooting, test setup diagram.

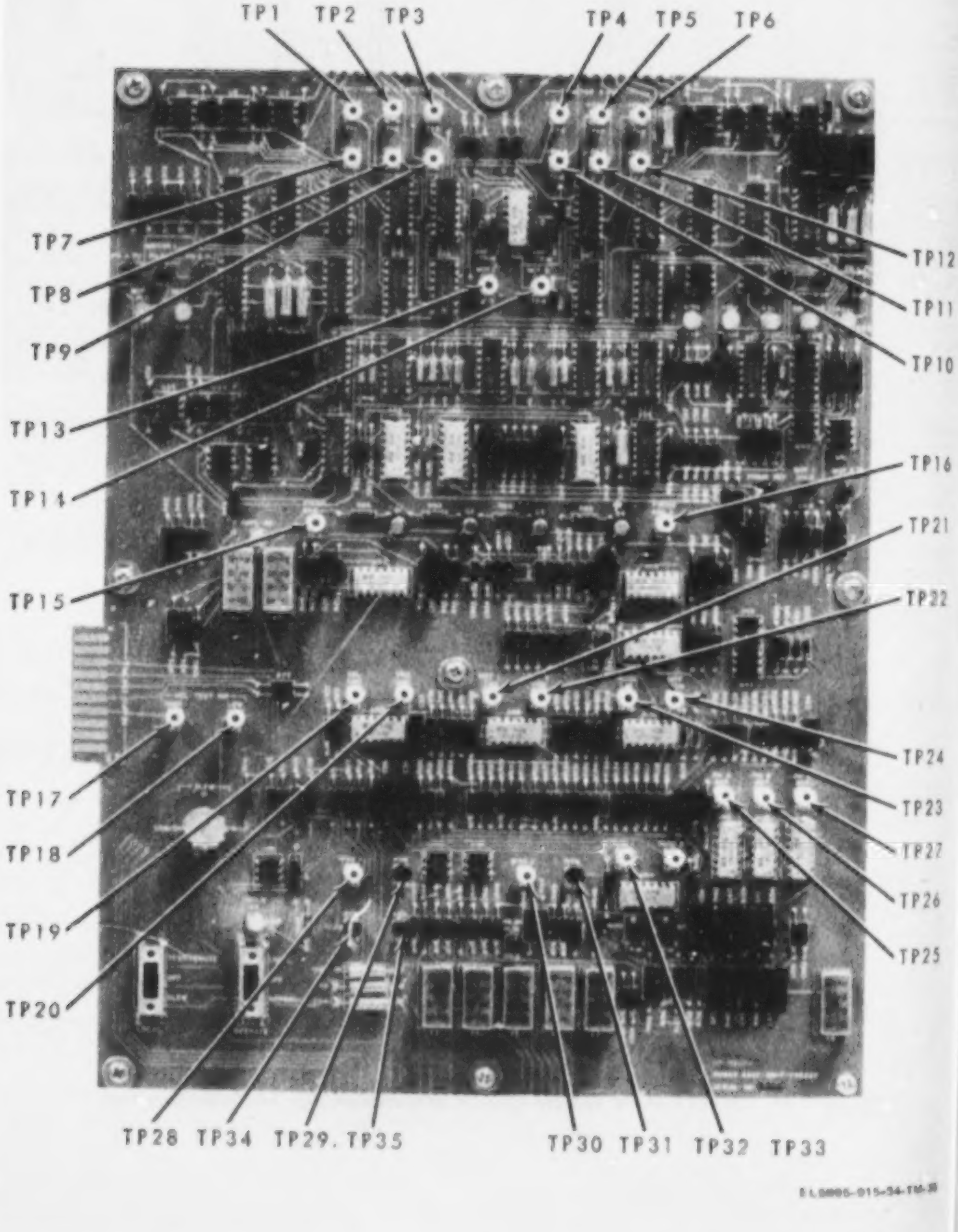
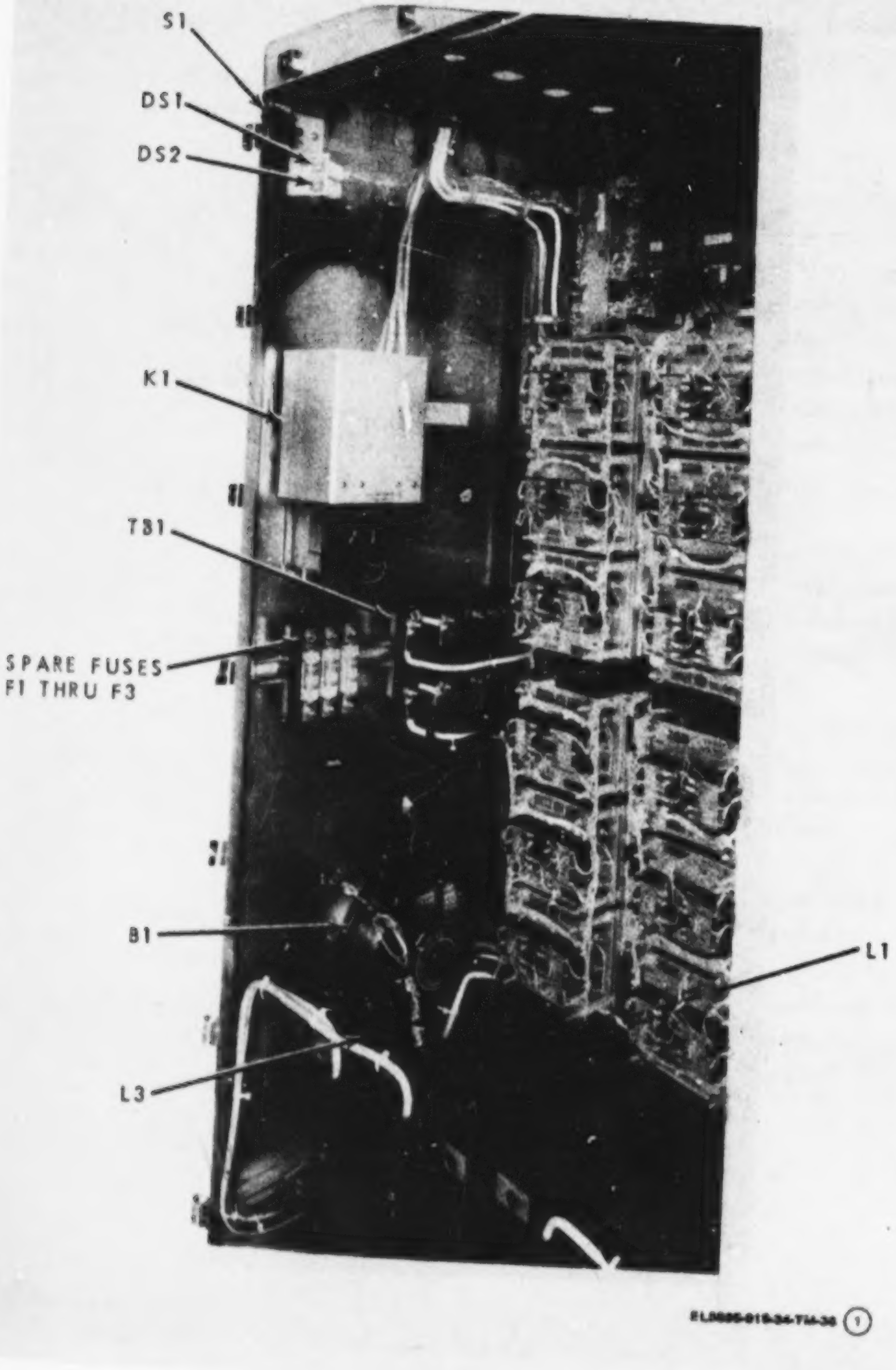

TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP9
TP13
TP14
TP15
TP17
TP18
TP19
TP20
TP12
TP11
TP10
TP16
TP21
TP22
TP24
TP23
TP27
TP26
TP25
TP28
TP34
TP29
TP35
TP30
TP31
TP32
TP33
EL5895-915-34-TM-38

Figure 3-17. Test point locations on circuit card assembly HTA-9A2A1,9A3A1.


S1
DS1
DS2
K1
TB1
SPARE FUSES
F1 THRU F3
B1
L1
L3

EL5895-915-34-TM-36 ①

Figure 3-18. Direct current control HTA-9, parts location (sheet 1 of 2).

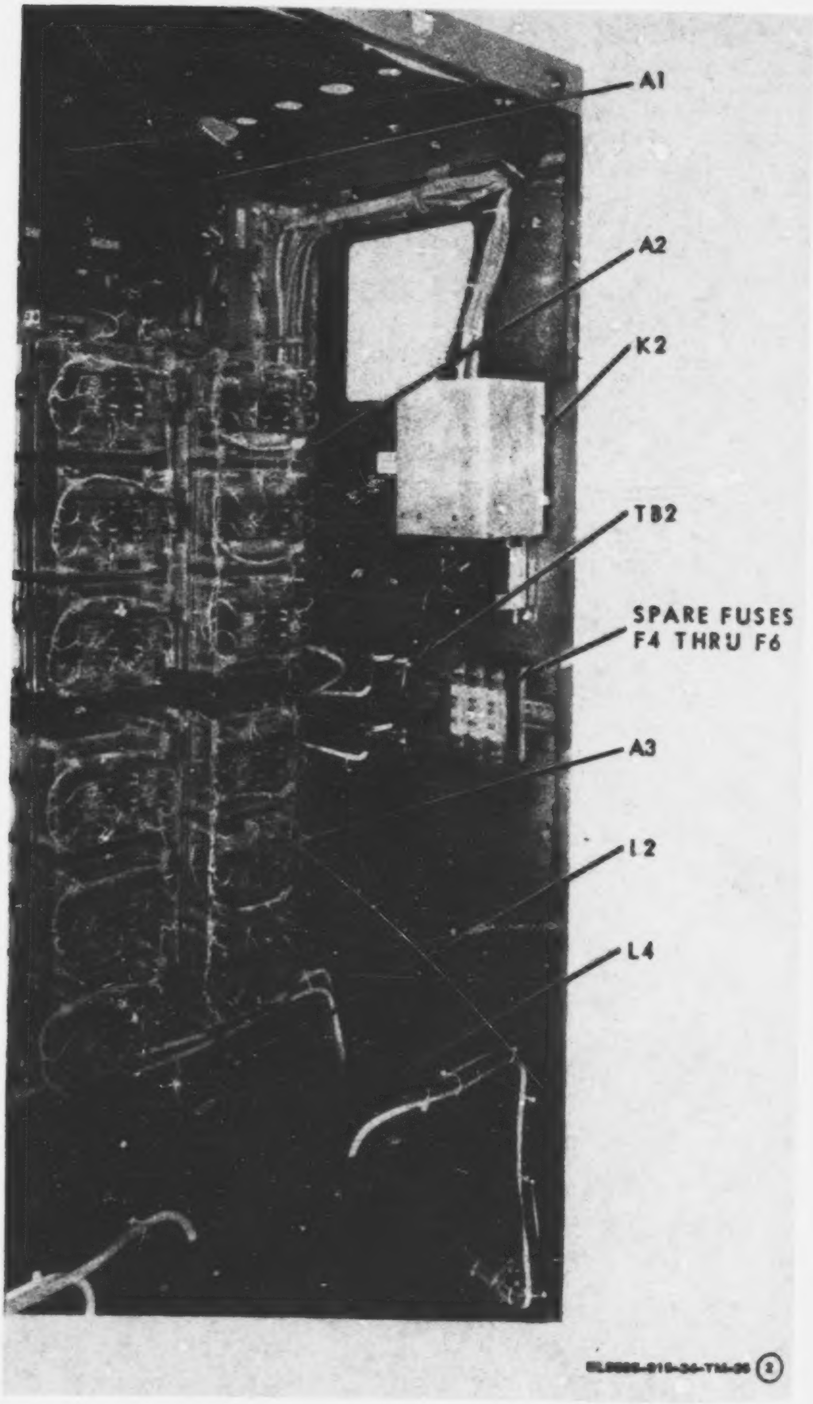

A1
A2
K2
TB2
SPARE FUSES
F4 THRU F6
A3
L2
L4
EL5895-915-34-TM-36 ②

Figure 3-18. Direct current control HTA-9, parts location (sheet 2 of 2).

d. Azimuth or Elevation Control Amplifier Circuit Card Assembly. Set OPERATE switch to LOCAL and LOCAL switch to SLEW.

e. Troubleshooting Procedure. After completing the preliminary procedures, perform the necessary steps in table 3-12 as specified by the symptom/probable cause listing below. The direct current control HTA-9 block diagram (fig. FO-17) and interconnection diagram (fig. FO-18) will assist in performing the basic troubleshooting procedures. Refer to figure 3-18 for parts location. When a fault is isolated to an electronic control amplifier or power supply control, proceed to troubleshooting procedures for that unit (para 3-34 or 3-35, respectively). When a fault is isolated to a cabinet-mounted component, repair or replace the component as specified in section XV. When a faulty subassembly or cabinet-mounted component has been replaced, either perform the applicable performance test procedures described in sections XXVII through XXXII or repeat the step in the troubleshooting table where the fault was found. Upon satisfactory completion of either the performance test or the step(s) in the troubleshooting table, the direct current control can be returned to service.

Symptom	**Probable cause**
Operator is unable to position antenna with AZIMUTH handcrank or AZ SLEW control on antenna control panel, in manual mode.	Electronic control amplifier A3 faulty. Refer to step 7.
Operator is unable to position antenna with ELEVATION handcrank or EL SLEW control on antenna control panel in manual mode.	Electronic control amplifier A2 faulty. Refer to step 7.
BRAKES MANUALLY RELEASED indicator on antenna position and status panel is lit (amber), brakes not manually released.	Electronic control amplifier A2 or A3 faulty. Refer to step 7.
SCR FAILURE indicator on antenna position and status panel is lit (red).	Power supply control A1 or electronic control amplifier A2 or A3 faulty. Refer to steps 7 (A2 or A3) and 8 (A1).
MINOR DRIVE FAULT indicator on antenna position and status panel is lit (amber).	Electronic control amplifier A2 or A3 faulty. Refer to step 7.
Antenna operates erratically in azimuth axis in autotrack or manual mode.	a. Power inductor L1 or L3 faulty. Refer to step 5. b. Electronic control amplifier A3 faulty. Refer to step 7.
Antenna operates erratically in elevation axis in autotrack or manual mode.	a. Power inductor L2 or L4 faulty. Refer to step 6. b. Electronic control amplifier A2 faulty. Refer to step 7.
INTLK OK LED on electronic control amplifier A2 or A3 is not lit.	Interlock switch S1 is faulty. Refer to step 1.
AMPL ON and MOT 1 and MOT 2 FLD indicator on electronic control amplifier A2/A3 are not lit.	Magnetic contactor K1/K2 is faulty. Refer to step 2/3.

Table 3-12 Direct Current Control HTA-9 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional check and remarks
1	Door interlock S1	OPERATE switch is set to LOCAL and LOCAL switch to OFF.	None	INTLK OK LED (DS18) on both A2 and A3 electronic control amplifiers is lit.	If DS18 on either pan off, re place interloc switch S1.
2	AZ magnetic contactor K1		None	Contactor K1 is activated, AMPL ON and MOT 1 and MOT 2 FLD indicators on A2 are lit.	If all three lights are place contactor K1.
3	EL magnetic contactor K2		None	Contactor K2 is activated, AMPL ON and MOT 1 and MOT 2 FLD indicators on A3 are lit.	If all three lights are place contactor K2
4	Cabinet FAN B1		None	Fan is operating.	If no air movement is side port, check LED cators DS9 thru DS any indicator is lit fan (section XV).
5	Power inductor L1 (or L3)	LOCAL switch S1 on elevation electronic control amplifier is set to SLEW, SLEW control R110 is operated to nominal 90-degree-from-0 position.	Connect oscilloscope test leads to TP13 (+) and TP34 (rtn)	+1.5 V	If indication is abnorm (with all indicators vation electronic con amplifier indicating fault), check L1 (or resistance with vom lows: On power sup control, set CONTA TORS circuit break TRIPPED; remove cable from power L1, and check for op circuit. If open circ indicated, replace L L3).
6	Power inductor L2 (or L4)	Same as step 5, except electronic control amplifier is A3.	Same as step 5.	+1.5 V	Same as step 5, exc substitute azimuth vation and L2 (or L L1 (or L3).
7	Electronic control amplifier A2 (or A3)	OPERATE switch set to LOCAL; LOCAL switch set to SLEW.	None	DS1 thru DS6, DS14, DS15, DS16, and DS19 are not lit.	If any indication is ab mal refer to paragra 34
8	Power supply control A1		None	F1 thru F4 are out, DS7 thru DS12 on A2 (or A3) are lit, DS17, and DS18 are lit.	If any indication is ab mal, refer to paragr 35.

3-34. Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting. This paragraph provides the instructions and procedures to isolate a malfunction to a major subassembly or component of electronic control amplifier A2 or A3.

a. Test Equipment and Materials. The test eq ment and materials required for troubleshooting tronic control amplifier are listed in table 3-13.

Table 3-13 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure

Common name	Part/model no.	Qty	Manufacturer
Adapter, BNC Plug to Dual Binding Post	103-0035-00	2	Tektronix
Adapter, 14 or 16 Pin DIP Test Clip	3916	1	Pomona
Ammeter, Clamp-on	749-2091001	1	Weston
Milliammeter, Volt-Ohm-(vom)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
Test Lead, Mini Trest Clip to Mini Test Clip	3781-12	2	Pomona

WARNING

CONTACTORS circuit breaker HTA-9A1CB2 controls application of the 277/480 V ac, 3-phase input to the scr assemblies. Do not perform any maintenance inside the cabinet with CONTACTORS circuit breaker CB2 set to ON.

WARNING

Use extreme care when performing maintenance inside the HTA-9 cabinet with the door interlock switch in the override position. Very high ac voltages (277/480 V ac) are present which could cause injury or death.

b. *Test Connections and conditions (fig. 3-19).* Troubleshooting an electronic control amplifier requires that the antenna be rotated on its axis and therefore cannot be performed while the terminal is operational. The servo equipment is connected in the normal operational configuration. The electronic control amplifier is set to operate in the local mode. Set up test equipment as shown in figure 3-19. When a procedure specifies a measurement or other operation inside the cabinet with power on, open the rear door and rotate the door interlock switch to the override position.

c. *Initial Control Settings.* On circuit card assembly A1, set OPERATE switch to LOCAL and LOCAL switch to OFF. Set test equipment controls as follows:

Control	Position
Dual-trace oscilloscope	
VERT MODE	CH 1
CH 1 VOLTS/DIV	As required
CH 1 AC-GND-DC	DC
HORIZ DISPLAY	A-LOCK KNOBS
TRIG MODE	NORMAL
INPUT COUPLING	DC
SOURCE	NORM
TIME/DIV	As required
A TRIGGER-SLOPE AND LEVEL	As required
TRIGGER HOLDOFF	NORM
10X MAG	Off (out)
Vom	
Function switch	AC
Range switch	10 V

d. *Troubleshooting Procedure.* Perform the steps in table 3-14 in the sequence given until the malfunction is isolated. The electronic control amplifier functional schematic diagram (fig. FO-19) and schematic diagram (fig FO-20) will assist in performing the troubleshooting procedure. Refer to figure 3-20 for parts location.

Table 3-14 Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Reference voltages		Connect vom (-) lead to TP35, (+) lead to TP25 (ph A). vom (-) lead to TP35, (+) lead to TP26, (ph B). Connect vom (-) lead to TP35, (+) lead to TP27 (ph C).	7.4 ±1 V ac	If any phase reference voltage is a normal, exchange A1 circuit ca assemblies and recheck TP's 25 and 27. follows circuit card, rep defective A1. If trouble does no low circuit card, replace transfo T1 or resistor for failed phase (ph A, R2-ph B, R3-ph C). (Re section XV).
2	Trigger outputs (motor 1)	Set LOCAL switch to OFF AND OPERATE switch to LOCAL.	Ref. fig. 3-19 Connect oscilloscope chan 1 to TP1 (+ph A), ground lead to TP34. Connect oscilloscope chan 1 to TP2 (+ph B). Connect oscilloscope chan 1 to TP3 (+ph C). Connect oscilloscope chan 1 to TP7 (-ph A). Connect oscilloscope chan 1 to TP8 (-ph B). Connect oscilloscope chan 1 to TP9 (-ph C).	4.5 ±0.5 V dc trigger pulses.	If any indication is abnormal, rep the circuit card. (Refer to sectio XV.)
3	Trigger outputs (motor 2)		Connect oscilloscope chan 1 to TP4 (+ph A), ground lead to TP34. Connect oscilloscope chan 1 to TP5 (+ph B). Connect oscilchan 1 to TP5 (+ph B). Connect oscilloscope chan 1 to TP6 (+ph C). Connect oscilloscope chan 1 to TP10 (-ph A). Connect oscilloscope chan 1 to TP11 (-ph B). Connect oscilloscope chan 1 to TP12 (-ph C).	4.5 ±0.5 V dc trigger pulses.	If any indication is abnormal, re the circuit card. (Refer to sect XV.)
4	Trigger pulses	Set LOCAL switch to SLEW and SLEW control to 25 pct of CW rotation.	Connect oscilloscope chan 1 to TP1 (+ph A, Motor 1). Connect oscilloscope chan 1 to TP2 (+ph B, Motor 1). Connect oscilloscope chan 1 to TP3 (+ph C, Motor 1).	2.2 ±1 ms pulses at 16 to 20 ms intervals. (Negativegoing pulses from ±4.5 ±0.5 V dc to less than +0.5 V dc)	If any indication is abnormal an GATE indicator is lit, replace cuit card (section XV).

Table 3-14 Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure - Continued

ep	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
			Connect oscilloscope chan 1 to TP4 (+ph A, Motor 2).		
			Connect oscilloscope chan 1 to TP5 (+ph B, Motor 2).		
			Connect oscilloscope chan 1 to TP6 (+ph C, Motor 1).		
			Connect oscilloscope chan 1 to TP7 (-ph A, Motor 1).		
			Connect oscilloscope chan 1 to TP8 (-ph B, Motor 1).		
			Connect oscilloscope chan 1 to TP9 (-ph C, Motor 1).		
			Connect oscilloscope chan 1 to TP10 (-ph A, Motor 2).		
			Connect oscilloscope chan 1 to TP11 (-ph B, Motor 2).		
			Connect oscilloscope chan 1 to TP12 (-ph C, Motor 2).		
	SCR assemblies (Motor 1+)	During following measurements, rotate SLEW control fully cw.	Connect clamp-on ammeter test leads to: A2 AC input, SCR A3 AC input, SCR A4 AC input.	Current in all three phases must be within 20 pct of each other.	If any indication is abnormal, replace defective scr assembly (section XV).
	SCR assemblies (Motor 1-)	During following measurements, rotate SLEW control fully ccw.	Connect clamp-on ammeter test leads to: SCR A2 AC input, SCR A3 AC input, SCR A4 AC input.	Same as step 5	Same as step 5
	SCR assemblies (Motor 2+)	Same as step 5	Connect clamp-on ammeter test leads to: SCR A5 AC input, SCR A6 AC input, SCR A7 AC input.	Same as step 5	Same as step 5
	SCR assemblies (Motor 2-)	Same as step 6	Connect clamp-on ammeter test leads to SCR	Same as step 5	Same as step 5

Table 3-14 Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
			A5 - output, SCR A6 - output, SCR A7 - output.		
9	Motor 1 overload circuit	LOCAL switch to OFF, OPERATE switch to NORMAL	None	MOT 1 OVLD indicator DS15 not lit.	If MOT 1 OVLD indicator is li AZ(EL) FUSE FAIL indicat stow pin control/minor fault s mary panel is out, replace circ card assembly A1. If MOT 1 OVLD indicator is lit and AZ FUSE FAIL indicator is lit (w GATE indicator lit) replace ov load sense relay K1.
10	Motor 2 overload circuit			MOT 2 indicator DS16 not lit.	If MOT 2 OVLD indicator is li AZ(EL) FUSE FAIL indicat stow pin control/minor fault s mary panel is out, replace circ card assembly A1. If MOT 2 OVLD indicator is lit and AZ FUSE FAIL indicator is lit (w GATE indicator lit) replace ov load sense relay K2.
11	SCR failure circuit			a. +5 V dc indicator DS11 lit	a. If +5 V dc indicator and SC FAILURE are both out, rep circuit card assembly A1 (sec XV). If +5 V dc indicator is o and SCR FAILURE indicat check power supply control (p 35).
				b. +26 V indicator DS13 lit	c. If +26 V dc indicator is out a INTLK OK indicator is out, servo power supply assembl tion V). If +26 V dc indicat and INTLK OK indicator is l place circuit card assembly A tion XV).
				c. +15 GATE indicator DS12 lit	c. If +15 GATE indicator and S FAILURE are both out, repla cuit card assembly A1 (sectio If +15 GATE indicator is ou • SCR FAILURE indicator is check power supply control (p 35).
				d. +15 V dc indicator DS9 lit	d. If +15 V dc indicator and SC FAILURE indicator on ante sition and status panel are bo replace circuit card assembly (section XV). If +15 V dc ind is out and SCR FAILURE in is lit, check power supply con (para (3-35).
				e. -15 V dc indicator DS10	e. If -15 V dc indicator and SC FAILURE indicator on ante

Table 3-14 Electronic Control Amplifier HTA-9A2, 9A3 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
				lit	sition and status panel are both out, replace circuit card assembly A1 (section XV). If -15 V dc indicator is out and SCR FAILURE indicator is lit, check power supply control (para 3 -35).
				f. PHASE REF indicator DS14 out.	f. If PHASE REF indicator is lit and SCR FAILURE indicator on antenna position and status panel is out, replace circuit card assembly A1 (section XV). If PHASE REF indicator and SCR FAILURE indicator are both lit, perform step 1 of this table.
				g. MOT 1 LFD indicator DS7 lit.	g. If MOT 1 LFD indicator is out, check power supply control (paras 3-35). If MOT 1 FLD indicator and SCR FAILURE indicator on antenna position and status panel are both out, replace circuit card assembly A1 (section XIV).
				h. MOT 2 FLD indicator DS8 lit.	h. If MOT 2 FLD indicator is out, check power supply control (para 3-35). If MOT 2 FLD indicator and SCR FAILURE indicator on antenna position and status panel are both out, replace circuit card assembly A1 (section XIV).
	Interlock circuit			INTLK OK indicator DS18 lit	If indication is abnormal, check cabinet door. If door is firmly closed and indicator remains off, replace interlock switch (section XV).
	Manual brake	Brakes manually released.		MNL BK RLSE indicator DS19 out	If indication is abnormal, replace circuit card assembly A1. Reset brakes.
	Fuse failure circuit			All fuse failure indicators (PH A FU, for example) DS1 thru DS6 are out.	If any fuse failure indicator is lighted, replace respective fuse (section XV).

3-35. Power Supply Control HTA-9A1 Troubleshooting. This paragraph provides the instructions and procedures to isolate a malfunction to a power supply or other component of power supply control A1.

a. Test Equipment and Materials. The only test equipment required for troubleshooting power supply control HTA-9A1 is a vom 260-6 and the test leads furnished with the vom.

WARNING

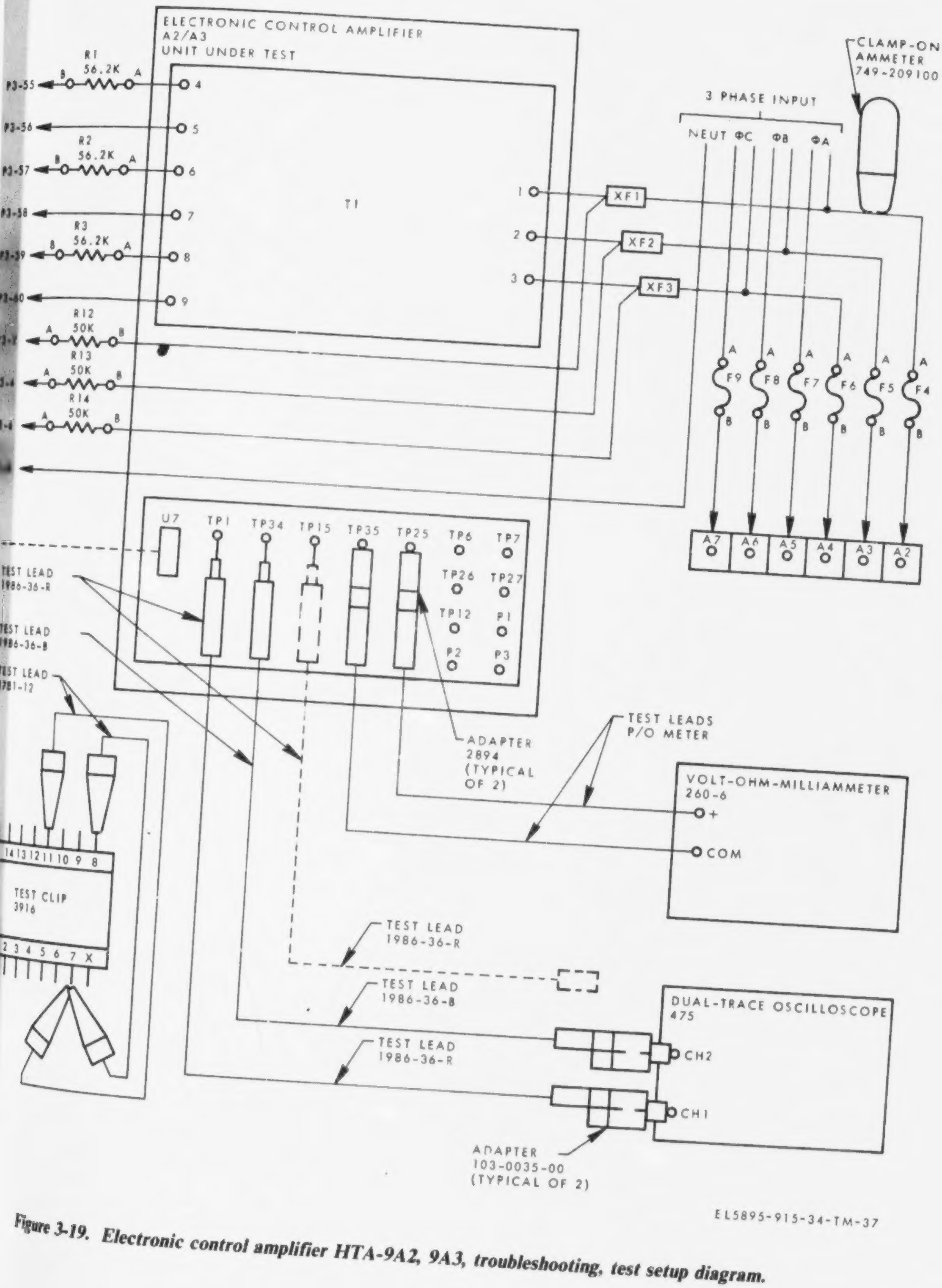
CONTACTORS circuit breaker HTA-9A1CB2 controls application of the 277/480 V ac, 3-phase input to the SCR assemblies. Do not perform any maintenance inside the cabinet with CONTACTORS circuit breaker CB2 set to ON.

WARNING

Use extreme care when performing maintenance inside the HTA-9 cabinet with the door interlock switch in the override position. Very high ac voltages (277/480 V ac) are present with switch in the override position.

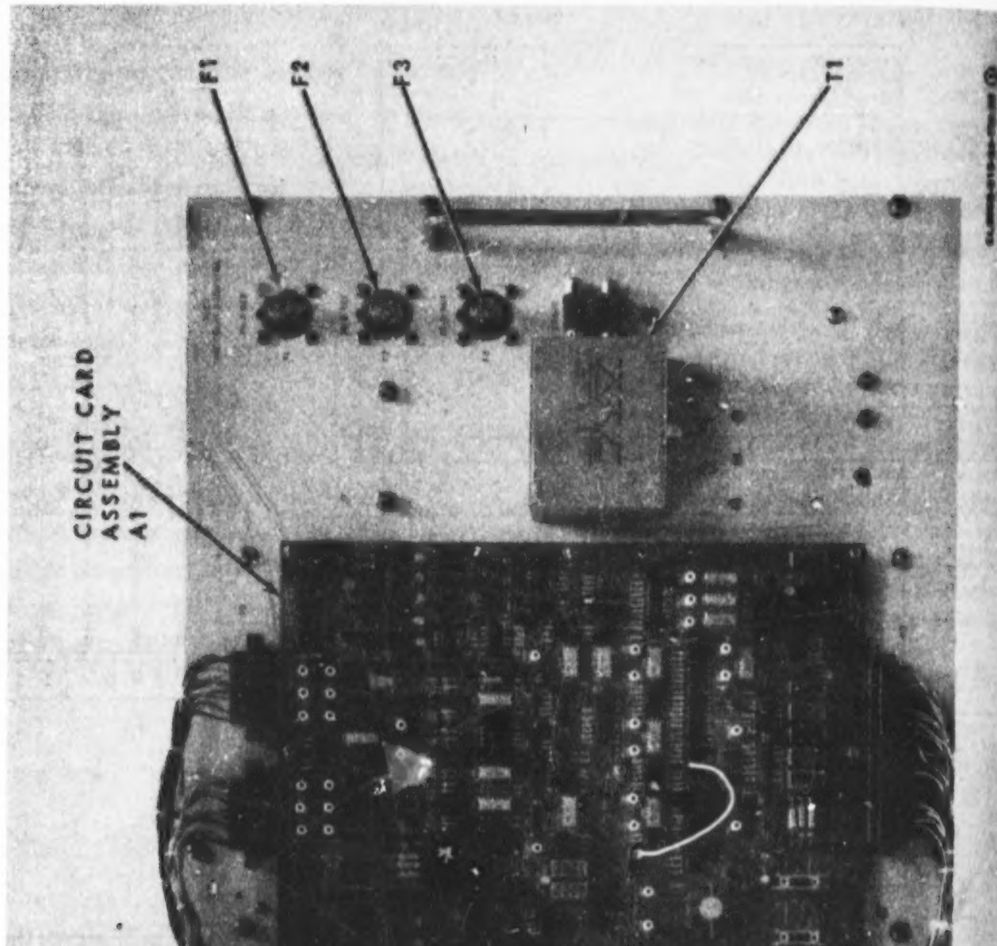
b. Test Connections and Conditions *(fig. 3*
Troubleshooting power supply control HTA-9A1 re
that the rear cabinet door of direct current control H
9 be opened and the door interlock override be set.
testing the power supplies at the rear of the power s
control, set CONTACTORS circuit breaker C
TRIPPED. The power supply control is connected
normal operational configuration. Set up the vom for
ing as shown in figure 3-21.

c. Initial Control Settings. Set vom range swi
10 V and function switch to +DC. Set CONTACT
circuit breaker CB2 to TRIPPED.


ELECTRONIC CONTROL AMPLIFIER
A2/A3
UNIT UNDER TEST
T1
R1
56.2K
R2
56.2K
R3
56.2K
R12
50K
R13
50K
R14
50K
P3-55
P3-56
P3-57
P3-58
P3-59
P3-60
XF1
XF2
XF3
CLAMP-ON
AMMETER
749-2091001
3 PHASE INPUT
NEUT
ΦC
ΦB
ΦA
F9
F8
F7
F6
F5
F4
A7
A6
A5
A4
A3
A2
U7
TP1
TP34
TP15
TP35
TP25
TP6
TP7
TP26
TP27
TP12
P1
P2
P3
TEST LEAD
1986-36-R
TEST LEAD
1986-36-B
TEST LEAD
3781-12
TEST CLIP
3916
ADAPTER
2894
(TYPICAL
OF 2)
TEST LEADS
P/O METER
VOLT-OHM-MILLIAMMETER
260-6
+
COM
TEST LEAD
1986-36-R
TEST LEAD
1986-36-B
TEST LEAD
1986-36-R
DUAL-TRACE OSCILLOSCOPE
475
CH2
CH1
ADAPTER
103-0035-00
(TYPICAL OF 2)

EL5895-915-34-TM-37

Figure 3-19. Electronic control amplifier HTA-9A2, 9A3, troubleshooting, test setup diagram.


F1
F2
F3
T1
CIRCUIT CARD ASSEMBLY A1
TB1
TB2
TB3
TB4

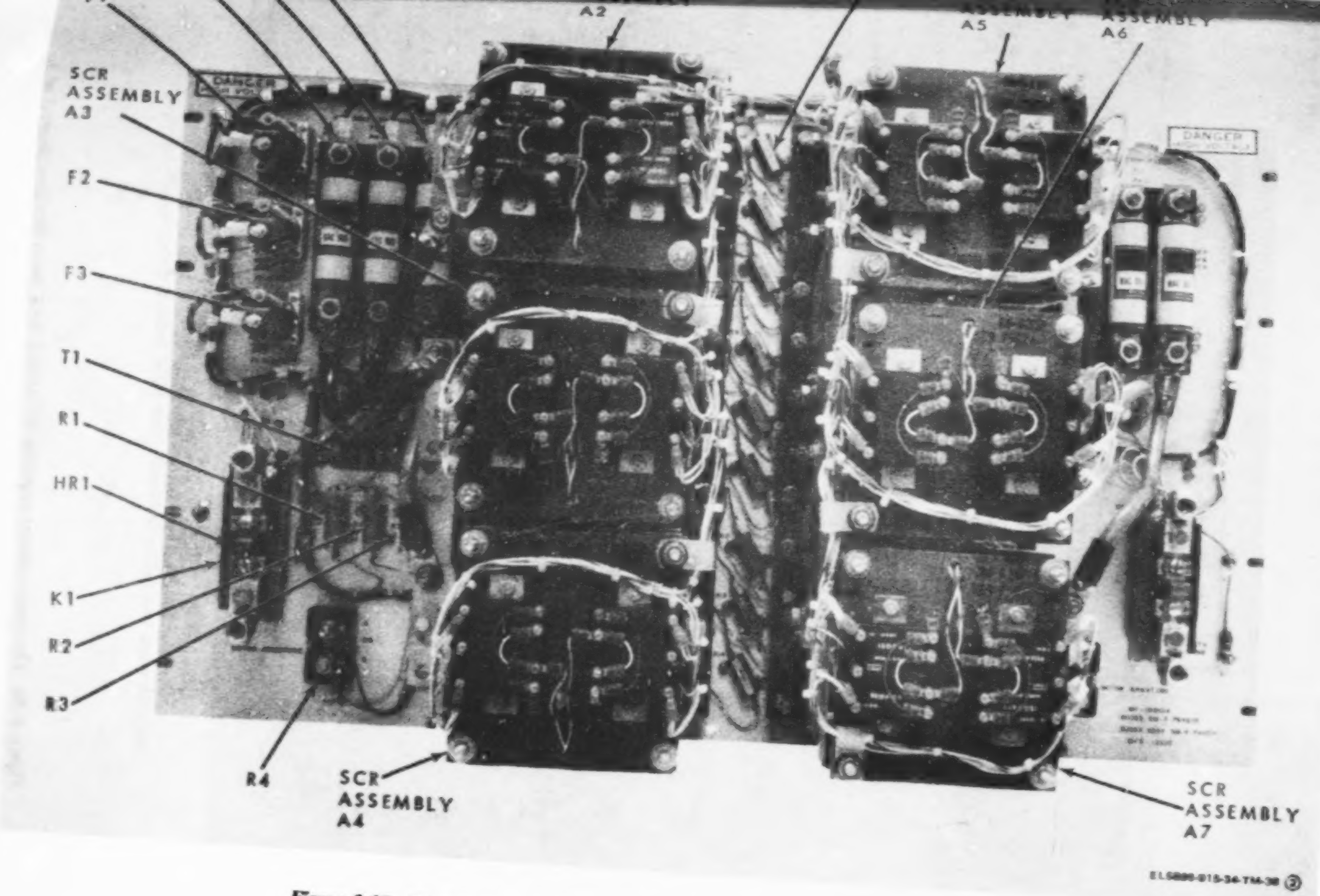

A2
ASSEMBLY
A5
ASSEMBLY
A6
SCR
ASSEMBLY
A3
DANGER
F2
F3
T1
R1
HR1
K1
R2
R3
R4
SCR
ASSEMBLY
A4
SCR
ASSEMBLY
A7
EL5895-915-34-TM-38 ③

Figure 3-20. Electronic control amplifier HTA-9A2, 9A3, parts location (sheet 2 of 3).

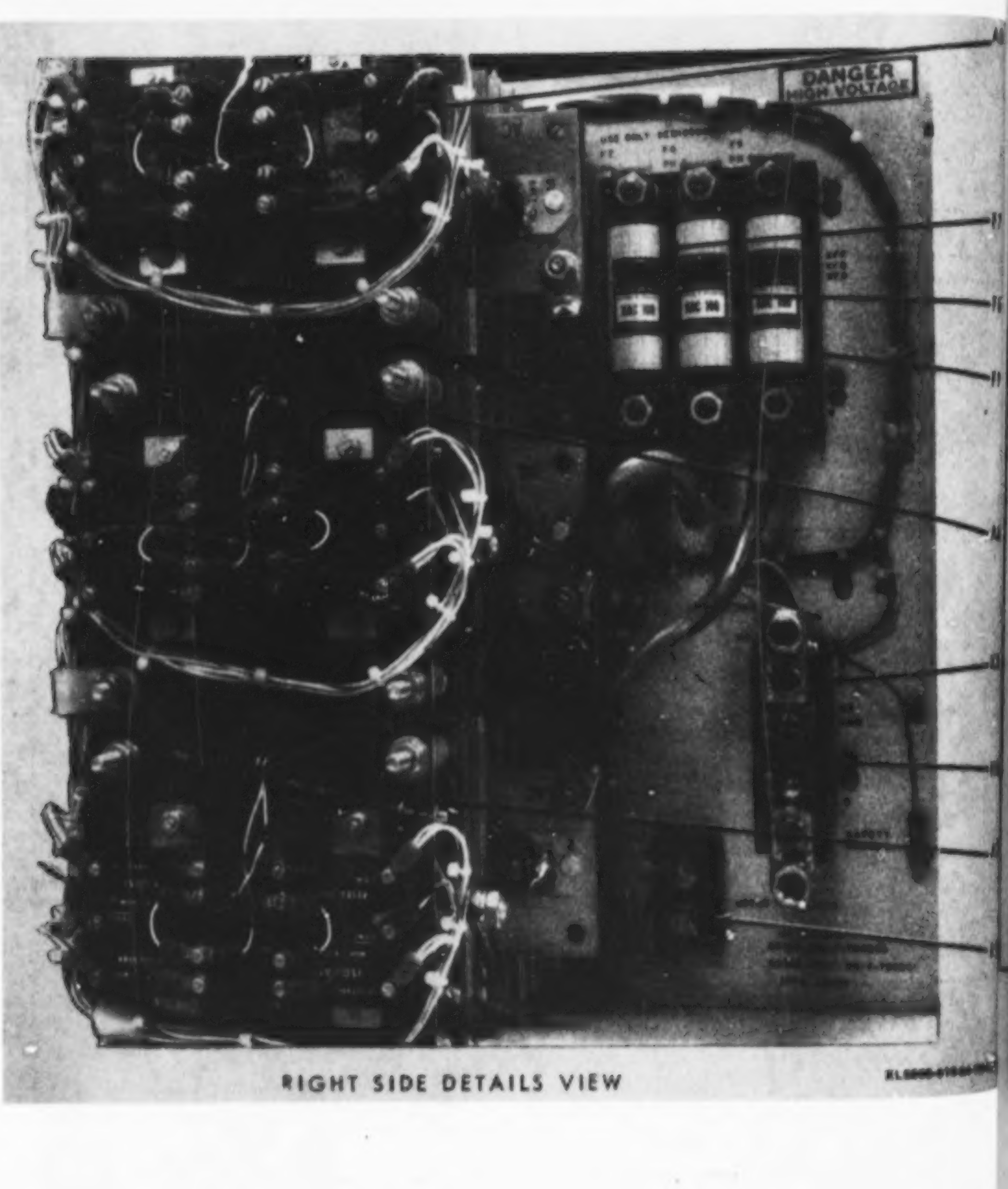

DANGER
HIGH VOLTAGE
RIGHT SIDE DETAILS VIEW

Figure 3-20. Electronic control amplifier HTA-9A2, 9A3, parts location (sheet 3 of 3).

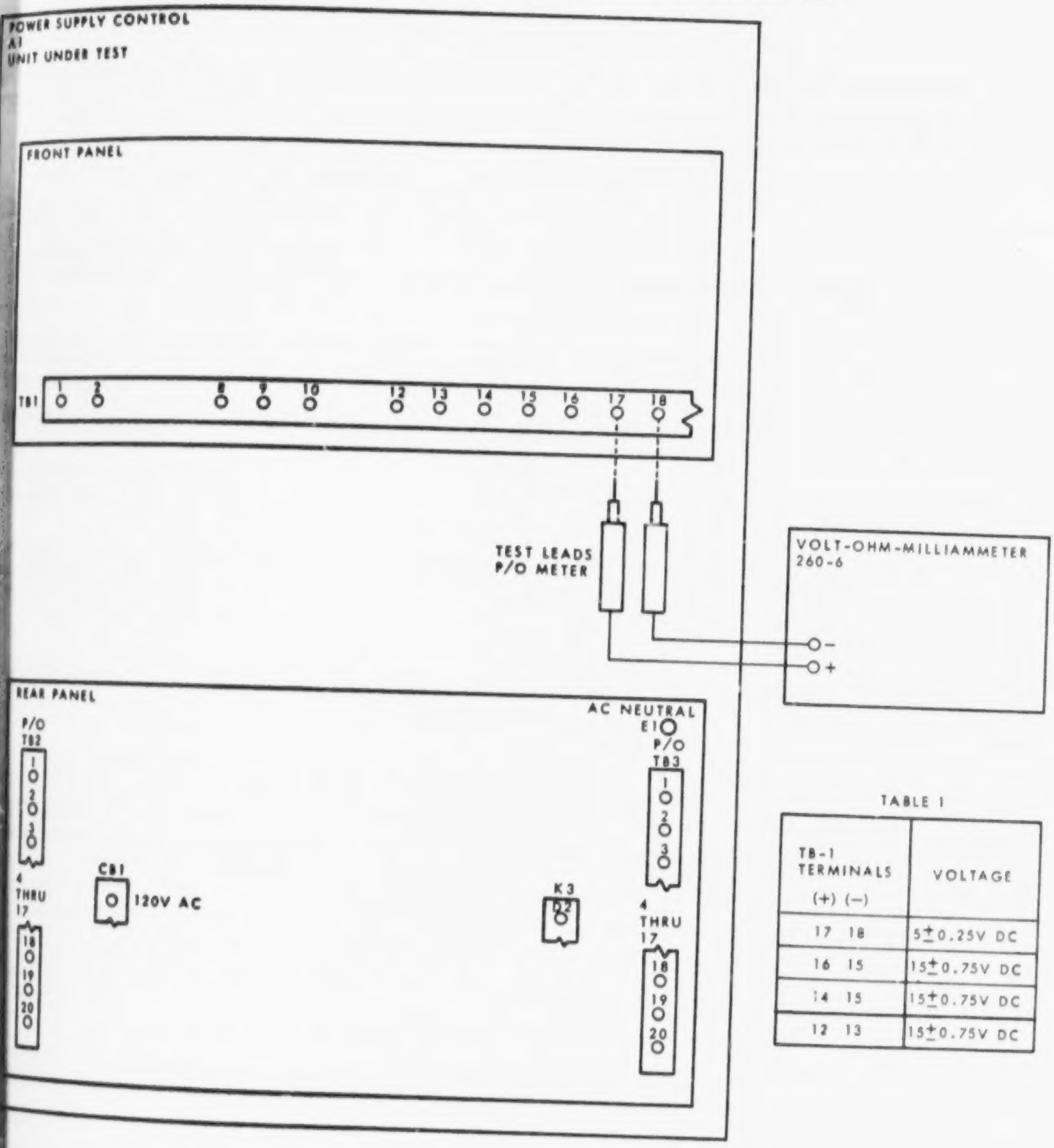

POWER SUPPLY CONTROL
A1
UNIT UNDER TEST
FRONT PANEL
TB1
1
2
8
9
10
12
13
14
15
16
17
18
TEST LEADS
P/O METER
VOLT-OHM-MILLIAMMETER
260-6
−
+
REAR PANEL
P/O
TB2
1
2
3
4
THRU
17
18
19
20
CB1
120V AC
K3
D2
AC NEUTRAL
E1
P/O
TB3
1
2
3
4
THRU
17
18
19
20

TABLE 1

TB-1 TERMINALS (+) (−)	VOLTAGE
17 18	5±0.25V DC
16 15	15±0.75V DC
14 15	15±0.75V DC
12 13	15±0.75V DC

EL5895-915-34-TM-41

Figure 3-21. Power supply control HTA-9A1, troubleshooting, test setup diagram.

d. Troubleshooting Procedure. Perform the steps in table 3-15 in the sequence given until the malfunction is isolated. The power supply control HTA-9A1 functional block diagram (fig. FO-26) and schematic diagra FO-27) will assist in performing the troubleshootin cedure. Refer to figure 3-22, for parts location.

Table 3-15 Power Supply Control HTA-9A1 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	+5 V dc power supply PS1	Set vom range switch to 10 V, function switch to +DC.	Connect vom (+) lead to TB1-17 and (-) lead to TB1-18.	+5 ±0.3 V dc	If indication is 0 volts, replac (section XV). If indication of tolerance, adjust powe output (section XV).
2	Dual 15 V dc power supply PS2 (-side)	Set vom range switch to 50 V, function switch to -DC.	Connect vom (+) lead to TB1-16 and (-) lead to TB1-15.	-15 ±1 V dc	If indication is 0 volts, replac (section XV). If indication is out of toleran adjust power supply outpu tion XV).
3	Dual 15 V dc power supply PS2 (+side)	Set vom function switch to +DC.	Connect vom (+) lead to TB1-12 and (-) lead to TB1-13.	+15 ±1 V dc	If indication is 0 volts, repla (section XV). If indicati of tolerance, adjust powe output (section XV).

WARNING

120/208 V ac is exposed on terminal boards TB2 and TB3 on the back side of A1 with cover plates removed.

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
4	Cabinet fan	Set vom function switch to AC, range switch to 250 V.	Remove TB2 and TB3 cover plates and connect vom (+) lead to TB2-19, and (-) lead to TB2-20.	120 ±12 V ac, fan operating	If indication is abnormal, re fan (section XV).

WARNING

When performing the following procedures, use extreme care. is present at the magnetic contactor inputs with CONTACTOR circuit breaker tripped. 120/208 V 3-phase power is present at all times on the power supply control terminal boards.

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
5	Az(El) magnetic contactor K1 (K2)	Operate CONTACTOR circuit breaker on/off for safety.	Connect vom (+) lead to TB2-10 (TB3-10).	120 ±12 V ac	If indication is abnormal, interlock relay K3 (sectio If indication is normal b netic contactors do not o replace magnetic contact tion XV).
6	Power-on flasher DS1/DS2		Connect vom (+) lead to TB2-12.	120 ±12 V ac	If indication is abnormal, interlock relay K3 (sect If indication is normal b er does not operate, repl flasher (section XV).

Table 3-15 Power Supply Control HTA-9A1 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
7	EL (AZ) motor 3-phase circuits		Connect vom (+) lead to TB2-1 (TB3-1). Connect vom (+) lead to TB2-2 (TB3-2). Connect vom (+) lead to TB2-3 (TB3-3).	120 ±12 V ac	If indication is abnormal, replace interlock relay K3 (section XV). If indication is normal but blower performance is erratic, check motor blower (section VIII)
8	Elevation motor field	Set vom range to 500 V Function to +DC.	Connect vom (+) lead to TB2-6, (-) lead to TB2-16.	240 ±24 V dc	If indication is abnormal, replace diode assembly CR1 (section I). If indication is normal but elevation motors are not functioning properly, or if motor field indicator DS7 or DS8 on A2A1 is out, check motors (section VIII)
9	Azimuth motor field		Connect vom (+) lead to TB3-6, (-) lead to TB3-16.	240 ±24 V dc	If indication is abnormal, replace diode assembly CR2 (section I). If indication is normal but azimuth motors are not functioning properly, or if motor field indicator DS7 or DS8 on A3A1 is out, check motors (section VIII).

3-36. +5 V DC Power Supply HTA-9A1PS1 Troubleshooting. This paragraph contains preliminary rocedures and troubleshooting procedures necessary for ocalizing a fault to a malfunctioning piece part of +5 V c power supply HTA-9A1PS1. The preliminary procedure consists of obtaining listed test equipment, making rescribed test connections, and initially setting equipent controls to specified settings. These settings, and all subsequent settings given in the troubleshooting chart must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement or adjustment of a malfunctioning component, refer to section XV in this chapter.

a. Test Equipment and Materials. Table 3-16 lists the test equipment and materials required for troubleshooting the power supply.

Table 3-16 Test Equipment Required for 5 V DC Power Supply HTA-9A1PS1 Troubleshooting Procedure

Common name	Part/model no.	Qty	Manufacturer
Line Cord	17449-S	1	Belden
pter, AC, 3-Wire to 2-Wire	785-0419	1	Allied
pter, Banana Jack to Minigator Clip	3448	3	Pomona
pter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
pter, Single Banana Plug to Binding Post	2894	2	Pomona
er, Multifunction	3450B	1	Hewlett-Packard

Table 3-16 Test Equipment Required for 5 V DC Power Supply HTA-9A1PS1 Troubleshooting Procedure - Continued

Common name	Part/model no.	Qty	Manufacturer
Milliammeter, Volt-Ohm- (vom)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Alligator Clip	1166-36-B	2	Pomona
Test Lead, Banana Plug to Alligator Clip	1166-36-R	1	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(B)	2	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(R)	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
Transformer, Variable	3PN2210	1	Staco

*b. **Test Connections and Conditions.*** Troubleshooting of the power supply is accomplished in a bench test setup. Test connections are illustrated in figure 3-23. Prior to performing the troubleshooting procedure, prepare the equipment for test as follows.

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

(3) On power supply, verify jumper wires are connected between terminals 3 and 4 and beteen terminals 6 and 7.

(4) Remove power supply cover (section XV).

(5) Connect test equipment as shown in figure 3-23.

*c. **Initial Test Equipment Settings.*** Initial test equipment settings for the troubleshooting procedures are as follows:

Control	Position
Multifunction meter	
LINE	ON (up)
FUNCTION	AC
RANGE	AUTO

Control	Position
Multifunction meter	
CONTROL	LOCAL
TRIGGER	INT
Oscilloscope	
POWER	ON (pull)
VERT MODE	CH 1
CH 1 VOLTS/DIV	As required to observe signal
CH 1 AC-GND-DC	AC
HORIZ DISPLAY	A-LOCK KNOB
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER - SLOPE AND LEVEL	As required for stable display
TRIGGER HOLD OFF	NORM
10X MAG	OFF (out)
Variable transformer	
Power switch	ON

d. Troubleshooting Procedure. Table 3-17 provides a step-by-step troubleshooting procedure to isolate a malfunction to a faulty part. Perform procedure in sequence given until malfunction is found. When a faulty part is isolated, replace part as directed in section XV. Test power supply as specified in section XXX of this chapter. Use the schematic diagram (fig. FO-28) as an aid in locating trouble causes and figure 3-24 for location of parts.

WARNING

120 V ac is present in this equipment. Serious injury or death may result if normal precautions are not observed. Front panel circuit breakers do not completely isolate the 120 V ac; this voltage still exists as a potential hazard at the circuit breaker input terminals. Do not take chances.

Table 3-17 5 V DC Power Supply HTA-9A1PS1 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	Power transformer T1 auxiliary rectifier secondary	As specified in paragraph 3-36b	As specified in paragraph 3-36b with multifunction meter connected between terminals M24 and M25 on PC board M	20 ±2 V ac	Check C10 for a short. Check T1 for open or shorted condition. shorted condition. Check C1 for shorted condition. Replace faulty item as directed in section XV of this chapter.
	Power transformer T1 main rectifier secondary		Connect multifunction meter between anode of CR3 and terminal M39 and then between anode of CB4 and terminal M39.	12.5 ±1.2 V ac	Check T1 for open or shorted condition. Replace faulty item as directed in section XV of this chapter.
	Main rectifier circuit	Multifunction meter: press DC FUNCTION switch.	Connect multifunction meter leads to power supply as follows: Meter lead – Power supply -(blk) – TB1-6 +(red) – Term M42 on pcb M	12.7 ±1.2 V dc	If reading is abnormal, check C6, C4, C14, CR3, and CR4 for a shorted or open condition. Replace faulty item as directed in section XV of this chapter.
	Bias supply		Connect multifunction meter test leads to power supply as follows: Test lead – Power supply -(blk) – TB1-6 +(red) – integrated circuit IC1, pin 14	21 ±0.1 V dc	Check CR1 and C1 for a shorted or open condition. Replace faulty item as directed in section XV of this chapter.
	Series voltage regulator circuit		Connect multifunction meter test leads to power supply as follows: Meter lead – Power supply -(blk) – TB1-4 +(red) – TB1-6	5 ±0.75 V dc	a. If voltage is present but not within tolerance, adjust VDC control R8. If voltage cannot be adjusted with R8, check R8 with ohmmeter for shorted and/or open condition. Replace, if faulty, as directed in section XV of this chapter b. If R8 is not faulty, power supply may be operating as constant

Table 3-17 5 V DC Power Supply HTA-9A1PS1 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
					current source at current li value. Check integrated cir IC1 and series regulator c with ohmmeter for shorted dition. Replace faulty item directed in section XV of th chapter. c. If output voltage is too high check R8 with ohmmeter fo open condition. Check Q2, (and Q3 for shorted condition Check pin 8 of IC! for an o condition. Replace faulty ite directed in section XV of th chapter. d. If output voltage is too low, check Q2 and Q3 with ohm ter for shorted condition. Re place faulty items as directe section XV of this chapter.
6	Filter	Twist oscilloscope test leads to cancel external noise signals when measuring ripple voltage.	Connect oscilloscope test leads to power supply as follows: Scope lead Power supply -(blk) TB1-3 +(red) TB1-7	Equal to or less than 2 mV ripple	a. If ripple is at the line freque or twice the line frequency, check CR1, CR3, and CR4 shorted or open condition. C C1, C6, and C10 for open co tion. Replace faulty item as d rected in section XV of this chapter. b. If large spikes are present, c C4 for an open condition. Re place faulty item as direct section XV of this chapter.

3-37. Dual 15 V DC Power Supply HTA-9A1PS2 Troubleshooting. This paragraph contains preliminary procedures and troubleshooting procedures for localizing a fault to a malfunctioning piece part of dual 15 V dc power supply HTA-9A1PS2. The preliminary procedures consist of obtaining listed test equipment, making prescribed test connections, and initially setting equipment controls to specified settings. These settings, and all subsequent settings given in the troubleshooting tabl be made carefully to ensure accurate test results. a troubleshooting procedure specifies replacement justment of a malfunctioning component, refer to se XV in this chapter.

a. Test Equipment and Materials. Table 3-1 the test equipment and materials required for tro shooting the dual 15 V dc power supply.

Table 3-18 Test Equipment Required for Dual 15 V DC Power Supply HTA-9A1PS2 Troubleshooting Procedure

Common name	Part/model no.	Qty	Manufacturer
AC Line Cord	17449-S	1	Belden
Adapter, AC, 3-Wire to 2-Wire	785-0419	1	Allied
Adapter, Banana Jack to Minigator Clip	3448	3	Pomona
Adapter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Meter, Multifunction	3450B	1	Hewlett-Packard
Milliammeter, Volt-Ohm- (vom)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Alligator Clip	1166-36-B	2	Pomona
Test Lead, Banana Plug to Alligator Clip	1166-36-R	1	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(B)	2	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(R)	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
Transformer, Variable	3PN2210	1	Staco

*b. **Test Connections and Conditions.*** Troubleshooting of the power supply is accomplished in a bench test setup. Test connections are illustrated in figure 3-25. Prior to performing the troubleshooting procedure, prepare the equipment for test as follows.

(1) Set vom function switch to AC and range switch to 250V. connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

(3) On dual 15 V dc power supply, verify jumper wires are connected between terminals 3 and 4, between terminals 6 and 7 (unit M), between terminals 11 and 12, and between terminals 14 and 15 (unit S).

(4) Remove power supply cover (section XV).

(5) Connect test equipment as shown in figure 3-25.

*c. **Initial Test Equipment Settings.*** Initial test equipment settings for the troubleshooting procedures are as follows:

Control	Position
Multifunction meter	
LINE	ON (up)
FUNCTION	AC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Oscilloscope	
Power	ON (pull)
VERT MODE	CH 1
CH 1 VOLTS/DIV	As required to observe signal

Control	Position
Oscilloscope	
CH 1 AC-GND-DC	AC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER - SLOPE AND LEVEL	As required for stable display
Trigger HOLD	OFF NORM
10X MAG +	OFF (out)
Variable transformer	
Power switch	ON

d. ***Troubleshooting Procedure.*** Tables 3-19 and 3- (M-unit and S-unit respectively) provide step-by- troubleshooting procedures to isolate a malfunction faulty part in either unit. Perform procedures in seque given until malfunction is found. If a faulty part is lated, replace part as specified in section XV. Test po supply as specified in section XXXI of this chapter. the schematic diagram (fig. FO-29) as an aid in loca trouble causes; use figure 3-26 for location of parts

WARNING

Hazardous voltages (120 V ac) may be encountered in performing the following troubleshooting procedure. Use caution at all times to prevent injury.

Table 3-19 Dual 15 V DC Power Supply HTA-9A1PS2 (M unit)
Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Power transformer T1 auxiliary rectifier secondary	As specified in paragraph 3-37b.	Connect as specified in paragraph 3-37b with multifunction meter connected between terminals M24 and M25 on pcb M.	22.5 ±2 V ac	Check C16 for a short. Check T for open or shorted conditio Check C5 for shorted conditio Replace faulty item.
2	Power transformer T1 main rectifier secondary		Connect multifunction meter between terminals M17 and M21 on pcb M.	27.5 ±3 V ac	Check T1 for open or shorted co dition. Check C5 for short. Re place faulty item.
3	Main rectifier circuit	Multifunction meter: DC FUNCTION switch.	Connect multifunction meter leads to power supply as follows: Meter lead / Power supply -(blk) TB1-6 +(red) Term M26 on pcb M.	21.1 ±2 V dc	Check C6 and CR2 thru CR5 fo a shorted or open condition. Re place faulty item.
4	Bias supply		Connect multifunction meter test leads to power supply as follows: Meter lead / Power supply -(blk) TB1-6 +(red) pin 14	21 ±0.2 V dc	Check CR1 and C1 for a short or open condition. Replace fau item.
5	Series voltage regulator circuit		Connect multifunction meter test leads to power supply as follows: Meter lead / Power supply	15 ±0.15 V dc	a. If voltage is present but not within tolerance, adjust VDC control R8. If voltage cannot adjusted with R8, check R8 ohmmeter for shorted or ope

Table 3-19 Dual 15 V DC Power Supply HTA-9A1PS2 (M unit) Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
			-(blk) TB1-4 +(red) TB1-6		condition. faulty item. b. If R8 is not faulty, power supply may be operating as constant current source at current limit value. Check integrated circuit IC1 and series regulator circuit with ohmmeter for shorted condition. Replace faulty item. c. If output voltage is too high, check R8 with ohmmeter for open condition. Check Q1 and Q2 for shorted condition and check pin 8 on IC1 for an open condition. Replace faulty item. d. If output voltage is too low, check integrated circuit IC1 for shorted condition and check R7 for open condition. Replace faulty item.
5	Filter circuits		Connect oscilloscope test leads to power supply as follows: Scope lead Power supply -(blk) TB1-3 +(red) TB1-7	Equal to or less than 2 mV ripple	a. If ripple is at the line frequency or twice the line frequency, check CR1 thru CR5 for shorted or open condition. Check C1, C6, and C16 for open conditions. Replace faulty item. b. If large spikes are present, check C5 for an open condition. Replace faulty item. c. If high ripple at frequency other than line or twice line frequency is present, check C7 or C2 for open and C11 or R2 for open or short condition. Replace faulty item.

Table 3-20 Dual 15 V DC Power Supply HTA-9A1PS2 (S Unit) Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional check and remarks
1	Power transformer T1 auxiliary rectifier secondary	As specified in paragraph 3-37b.	Connect as specified in paragraph 3-37b with multifunction meter connected between terminals S35 and S36 on PC board S.	22.5 ±2 V ac	Check C116 for a short. Ch for open or shorted condi Replace faulty item.
2	Power transformer T1 main rectifier secondary		Connect multifunction meter between terminals S28 and S32 on pcb S.	27.5 ±3 V ac	If indication is abnormal, che T1 and C105 for open or shorted condition. Replace faulty item.
3	Main rectifier circuit	Multifunction meter: press DC FUNCTION switch.	Connect multifunction meter leads to power supply as follows: Meter lead / Power supply -(blk) TB101-14 +(red) Term S37 on PC board M	21.1 ±2 V dc	Check C106 and CR102 thru CR105 for a open or shorte condition. Replace faulty ite
4	Bias supply		Connect multifunction meter test leads to power supply as follows: Meter lead / Power supply -(blk) TB101-14 +(red) PIN 14 of integrated circuit IC101	21 ±0.2 V dc	Check CR101 and C101 for a shorted or open condition Re place faulty item.
5	Series voltage regulator circuit		Connect multifunction meter test leads to power supply as follows: Meter lead / Power supply -(blk) TB101-12 +(red) TB101-14	15 ±0.75 V dc	a. If voltage is present but no within tolerance, adjust VDC control R108. If voltage ca be adjusted with R108, chec R108 with ohmmeter for shorted or open condition Re place faulty item. b. If R108 is not faulty, power supply may be operating as stant current source at curr limit value. Check integrated circuit IC101 and series regu tor circuit with ohmmeter shorted condition. Replace faulty item. c. If output voltage is too high check R108 with ohmmeter open condition. Check Q101 and Q102 for shorted condi Check pin 8 on IC101 for an open condition. Replace faulty item.

Table 3-20 Dual 15 V DC Power Supply HTA-9A1PS2 (S Unit) Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
					d. If output voltage is too low, check integrated circuit IC101 for shorted condition and check R107 for open condition. Replace faulty item.
6	Filter circuits		Connect oscilloscope test leads to power supply as follows: Scope lead - Power supply -(blk) TB101-11 +(red) TB101-15	Equal to or less than 2 mV ripple	a. If ripple is at the line frequency or twice the line frequency, check CR10 and CR102 thru CR105 for shorted or open condition. Check C101, C106 and C116 for open condition. Replace faulty item. b. If large spikes are present, check C105 for an open condition. Replace faulty item. c. If high ripple at frequency other than line frequency is present, check C107 and check C111 and R102 for open or shorted condition. Replace faulty item.

28. +15 V DC Gate Power supply HTA-9A1PS3 roubleshooting. This paragraph contains prelimina- procedures and troubleshooting procedures for localiz- a fault to a malfunctioning piece part of the +15 V gate power supply. The preliminary procedure consists obtaining listed test equipment, making prescribed test nections, and initially setting equipment controls to ecified settings. These settings, and all subsequent settings given in the troubleshooting chart must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement or adjustment of a malfunctioning component, refer to section XV in this chapter.

a. Test Equipment and Materials. Table 3-21 lists the test equipment and materials required for troubleshooting the +15 V dc gate power supply.

Table 3-21 Test Equipment Required for 15 V DC Gate Power Supply HTA-9A1PS3 Troubleshooting Procedure

Common name	Part/model no.	Qty	Manufacturer
Line Cord	17449-S	1	Belden
er, AC, 3-Wire to 2-Wire	785-0419	1	Allied
er, Banana Jack to Mingator Clip	3448	3	Pomona
er, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix

Table 3-21 Test Equipment Required for 15 V DC Gate Power Supply HTA-9A1PS3 Troubleshooting Procedure - Continued

Common name	Part/model no.	Qty	Manufactur
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Meter, Multifunction	3450B	1	Hewlett-Packar
Milliammeter, Volt-Ohm- (vom)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Alligator Clip	1166-36-B	2	Pomona
Test Lead, Banana Plug to Alligator Clip	1166-36-R	1	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(B)	2	Pomona

b. Test Connections and Conditions. Troubleshooting of the power supply is accomplished in a bench test setup. Test connections are illustrated in figure 3-27. Prior to performing the troubleshooting procedure, prepare the equipment for test as follows.

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.
(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.
(3) On +15 V dc gate power supply, verify jumper wires are connected between terminals 3 and 4 and between terminals 6 and 7.
(4) Remove power supply cover (section XV).
(5) connect test equipment as shown in figure 3-27.

c. Initial Test Equipment Settings. Initial test equipment settings for the troubleshooting procedures are as follows.

Control	Position
Multifunction meter	
LINE	ON (up)
FUNCTION	AC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Multifunction meter	
Oscilloscope	
Power	ON (pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe sig
CH1 AC-GND-DC	AC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe sig
A TRIGGER - SLOPE AND LEVEL	As required for stable disp
Variable transformer	
Power switch	ON

d. Troubleshooting Procedure. **Table 3-22 pr a step-by-step troubleshooting procedure to isolate function to a faulty part. Perform procedure in se given unitl malfunction is found. If a faulty part is replace part as directed in section XV and test supply as specified in section XXXII of this chapte the schematic diagram (fig. FO-30) as an aid to lo trouble causes; use figure 3-28 for location or par**

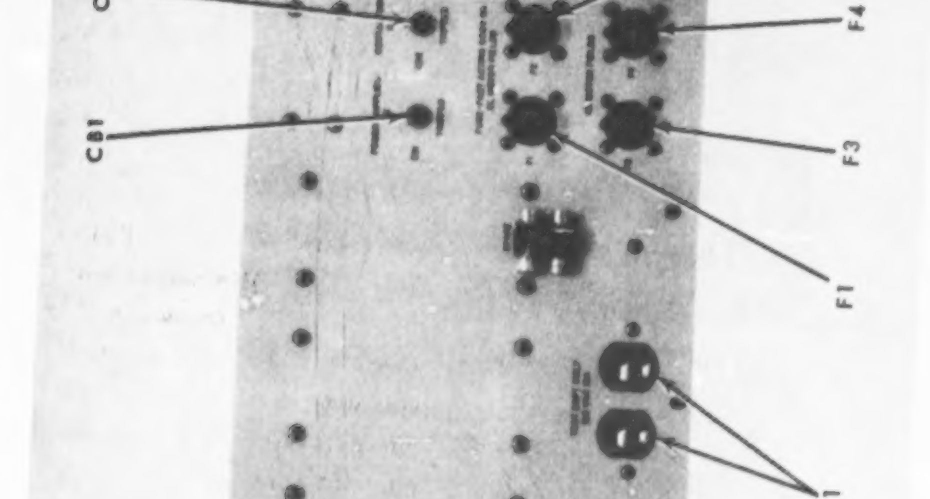
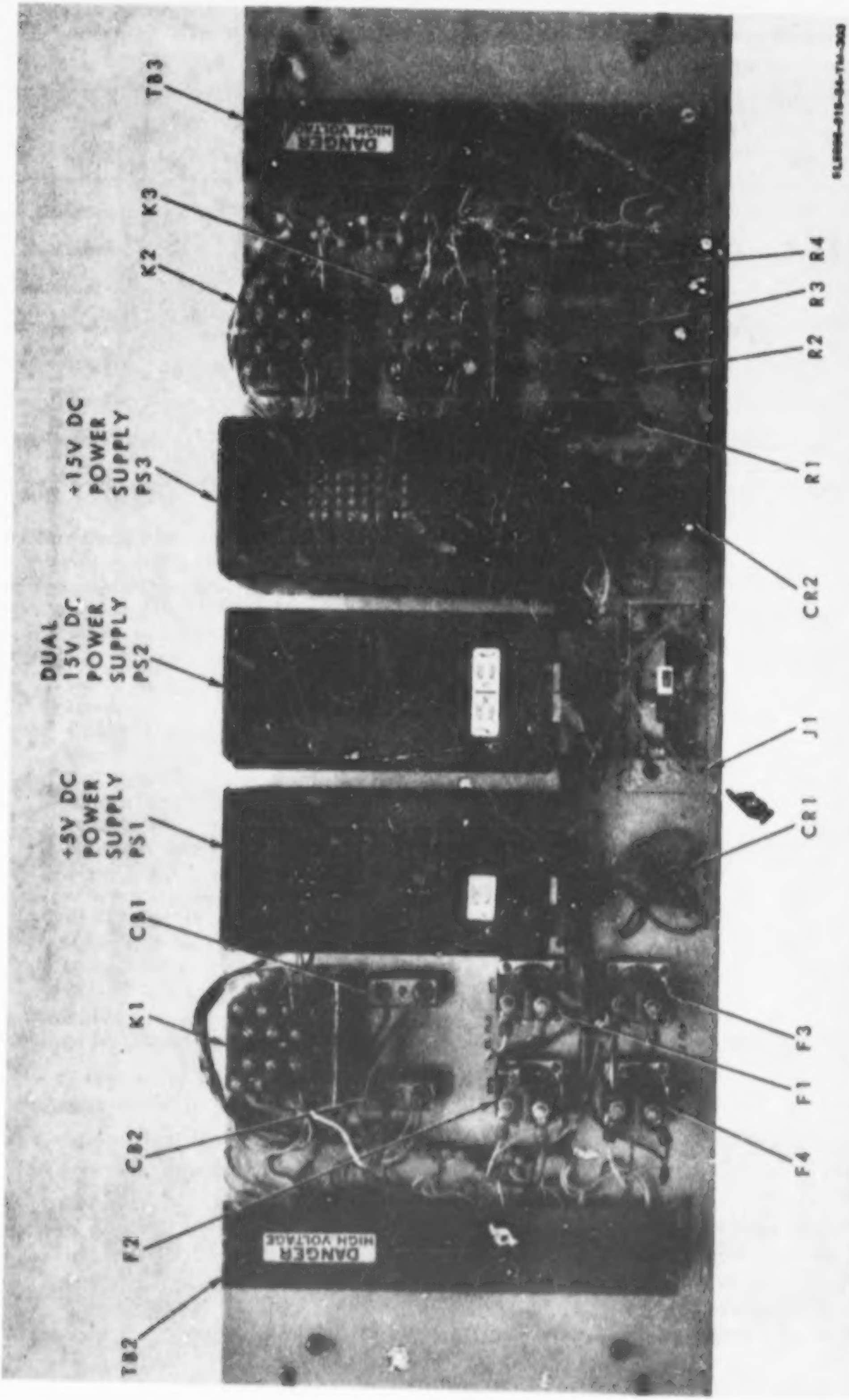

CB2
CB1
TB1
F2
F4
F3
F1
J1
EL5895-915-34-TM-42 ①

Figure 3-22. Power supply control HTA-9A1, parts location (sheet 1 of 3).


TB3
K3
K2
+15V DC POWER SUPPLY PS3
DUAL 15V DC POWER SUPPLY PS2
+5V DC POWER SUPPLY PS1
CB1
K1
CB2
F2
TB2
DANGER HIGH VOLTAGE
DANGER HIGH VOLTAGE
R4
R3
R2
R1
CR2
J1
CR1
F3
F1
F4
EL5895-915-34-TM-303

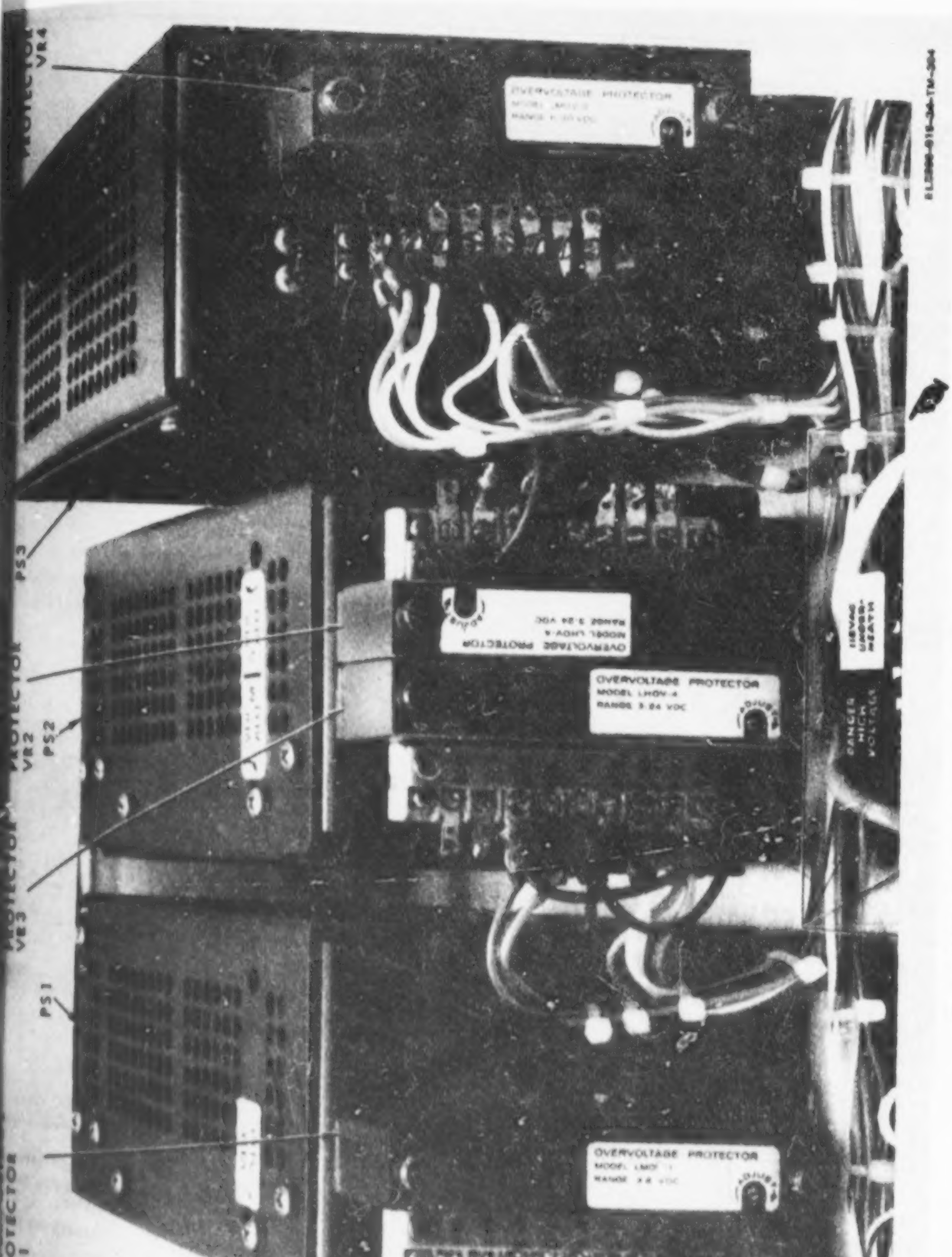
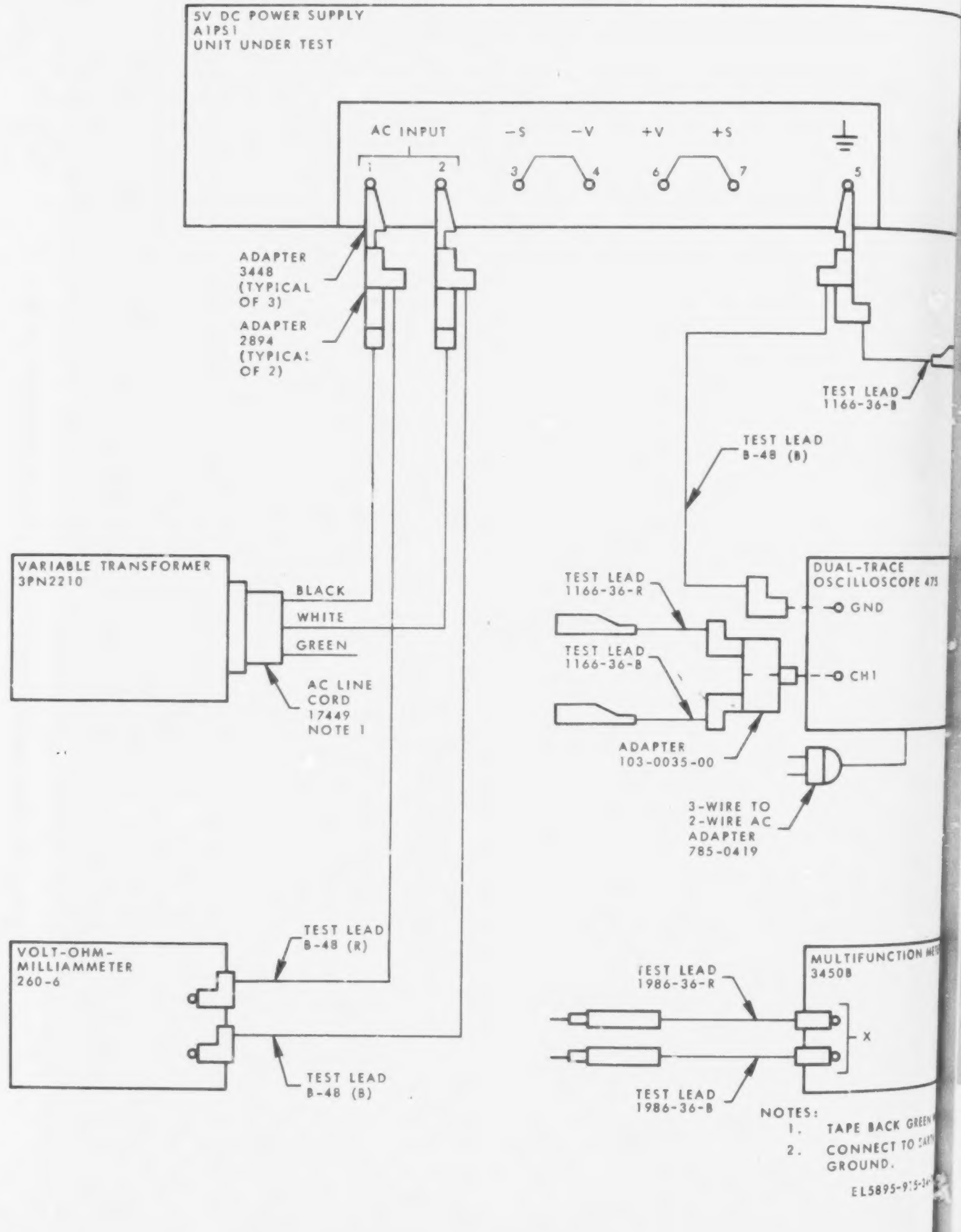

PROTECTOR
VR1
PS1
PROTECTOR
VR3
PS2
PROTECTOR
VR2
PS3
PROTECTOR
VR4
OVERVOLTAGE PROTECTOR
MODEL LHOV-4
RANGE 3-24 VDC
ADJUST
OVERVOLTAGE PROTECTOR
DANGER
HIGH
VOLTAGE
EL5895-915-34-TM-304

Figure 3-22. Power supply control HTA-9A1, parts location (sheet 3 of 3).


5V DC POWER SUPPLY
A1PS1
UNIT UNDER TEST
AC INPUT
1
2
−S
−V
+V
+S
3
4
6
7
5
ADAPTER 3448 (TYPICAL OF 3)
ADAPTER 2894 (TYPICAL OF 2)
TEST LEAD 1166-36-B
TEST LEAD B-48 (B)
VARIABLE TRANSFORMER 3PN2210
BLACK
WHITE
GREEN
AC LINE CORD 17449 NOTE 1
DUAL-TRACE OSCILLOSCOPE 475
GND
CH1
TEST LEAD 1166-36-R
TEST LEAD 1166-36-B
ADAPTER 103-0035-00
3-WIRE TO 2-WIRE AC ADAPTER 785-0419
VOLT-OHM-MILLIAMMETER 260-6
TEST LEAD B-48 (R)
TEST LEAD B-48 (B)
MULTIFUNCTION
3450B
TEST LEAD 1986-36-R
TEST LEAD 1986-36-B
X
EL5895-915-34

NOTES:
1. TAPE BACK GREEN
2. CONNECT TO
GROUND.

Figure 3-23. +5 V dc power supply HTA-9A1PS1, troubleshooting and voltage adjustment, test setup

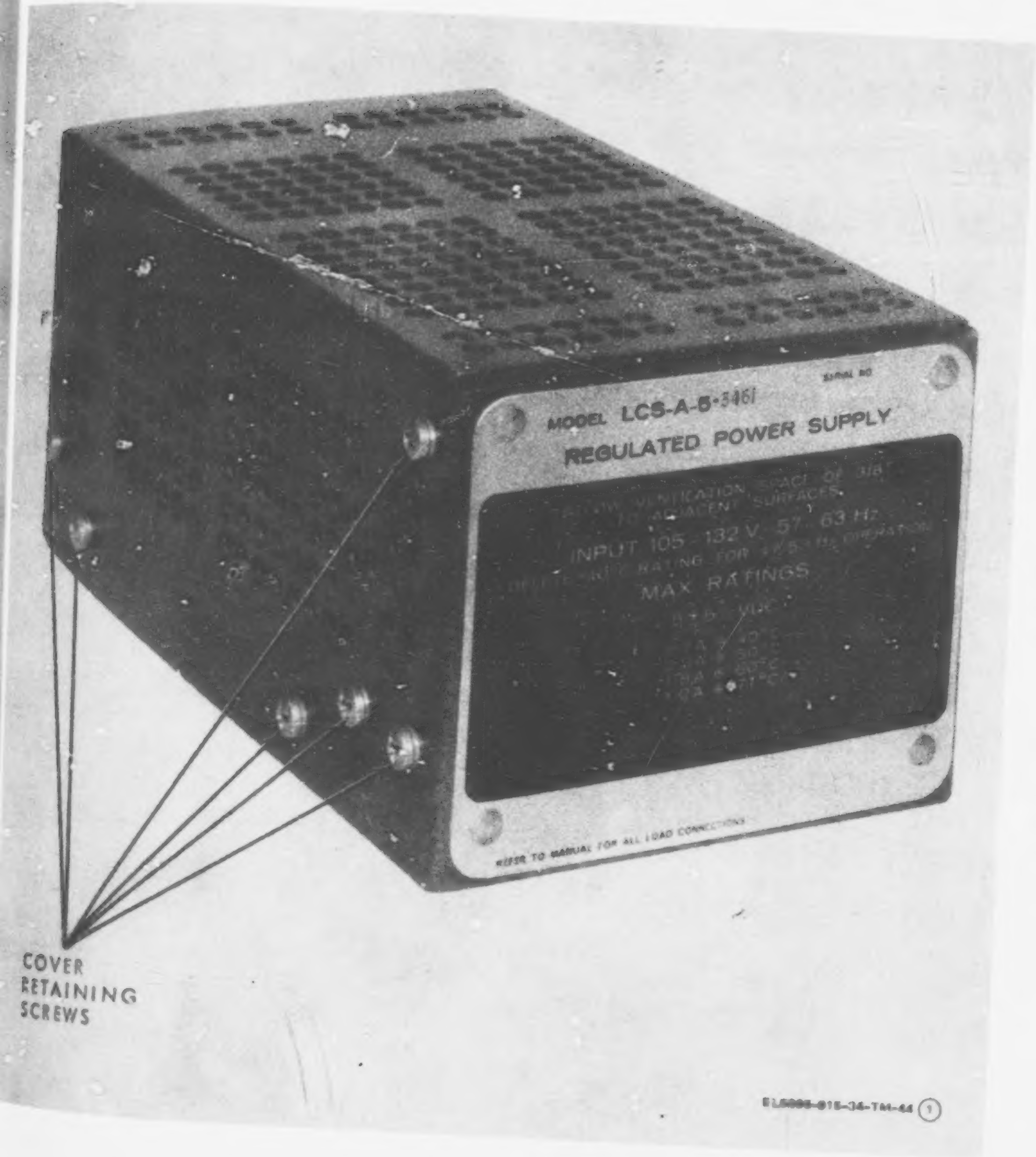
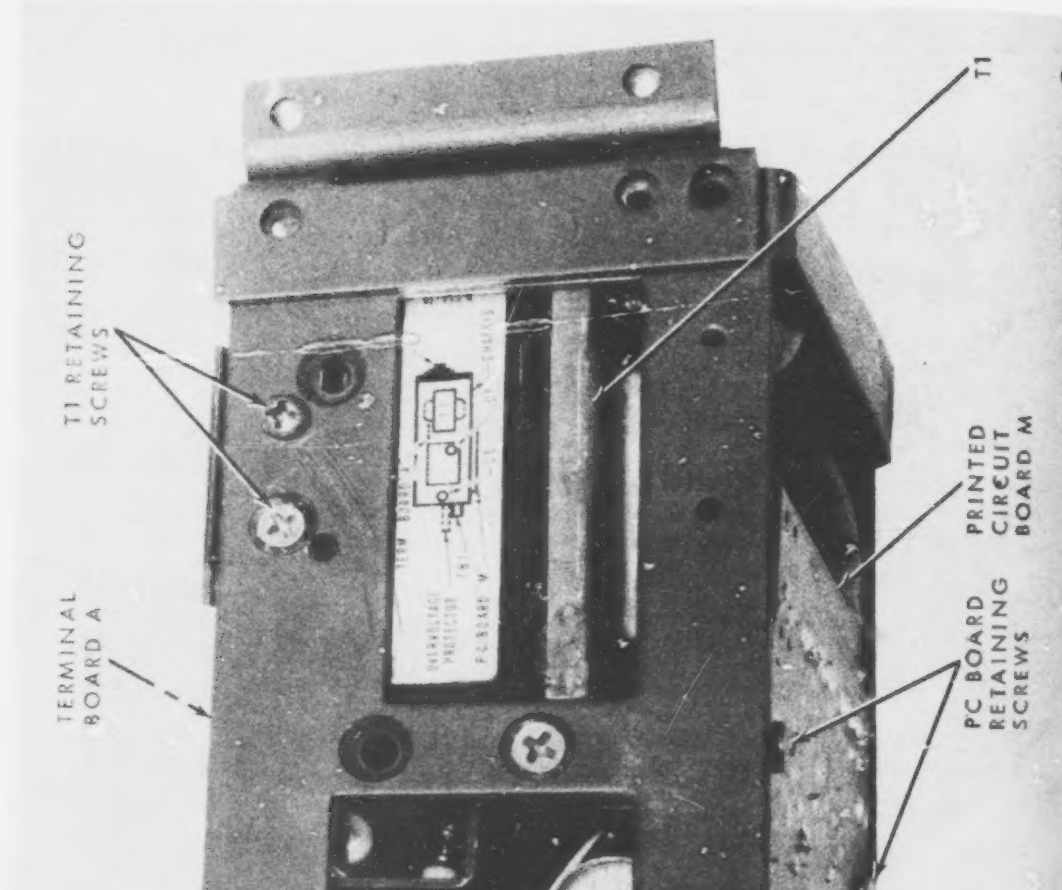

MODEL LCS-A-5-3461
REGULATED POWER SUPPLY
INPUT 105 - 132 V 57 - 63 Hz
MAX RATINGS
REFER TO MANUAL FOR ALL LOAD CONNECTIONS
COVER RETAINING SCREWS
EL5895-915-34-TM-44 ①

Figure 3-24. +5 V dc power supply HTA-9A1PS1, parts location (sheet 1 of 4).


T1 RETAINING SCREWS
TERMINAL BOARD A
C7
C6
TB1
T1
PRINTED CIRCUIT BOARD M
PC BOARD RETAINING SCREWS
TERM BOARD A
OVERVOLTAGE PROTECTOR
TB1
P.C. BOARD M
CHASSIS
EL5895-915-34-TM-44 ②

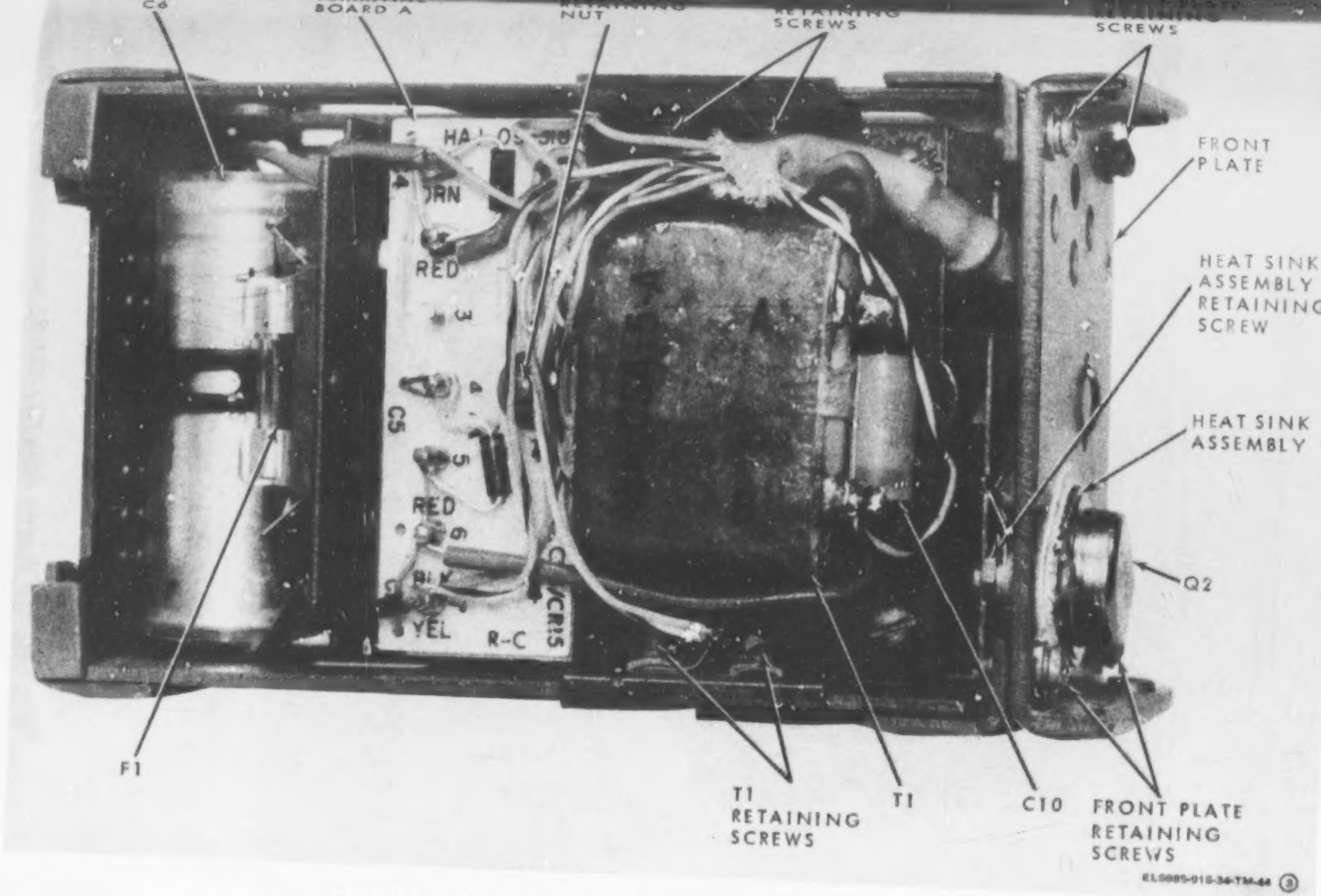

C6
BOARD A
NUT
SCREWS
SCREWS
FRONT PLATE
HEAT SINK ASSEMBLY RETAINING SCREW
HEAT SINK ASSEMBLY
Q2
F1
T1 RETAINING SCREWS
T1
C10
FRONT PLATE RETAINING SCREWS
EL5895-915-34-TM-44 ③

Figure 3-24. +5 V dc power supply HTA-9A1PS1, parts location (sheet 3 of 4).

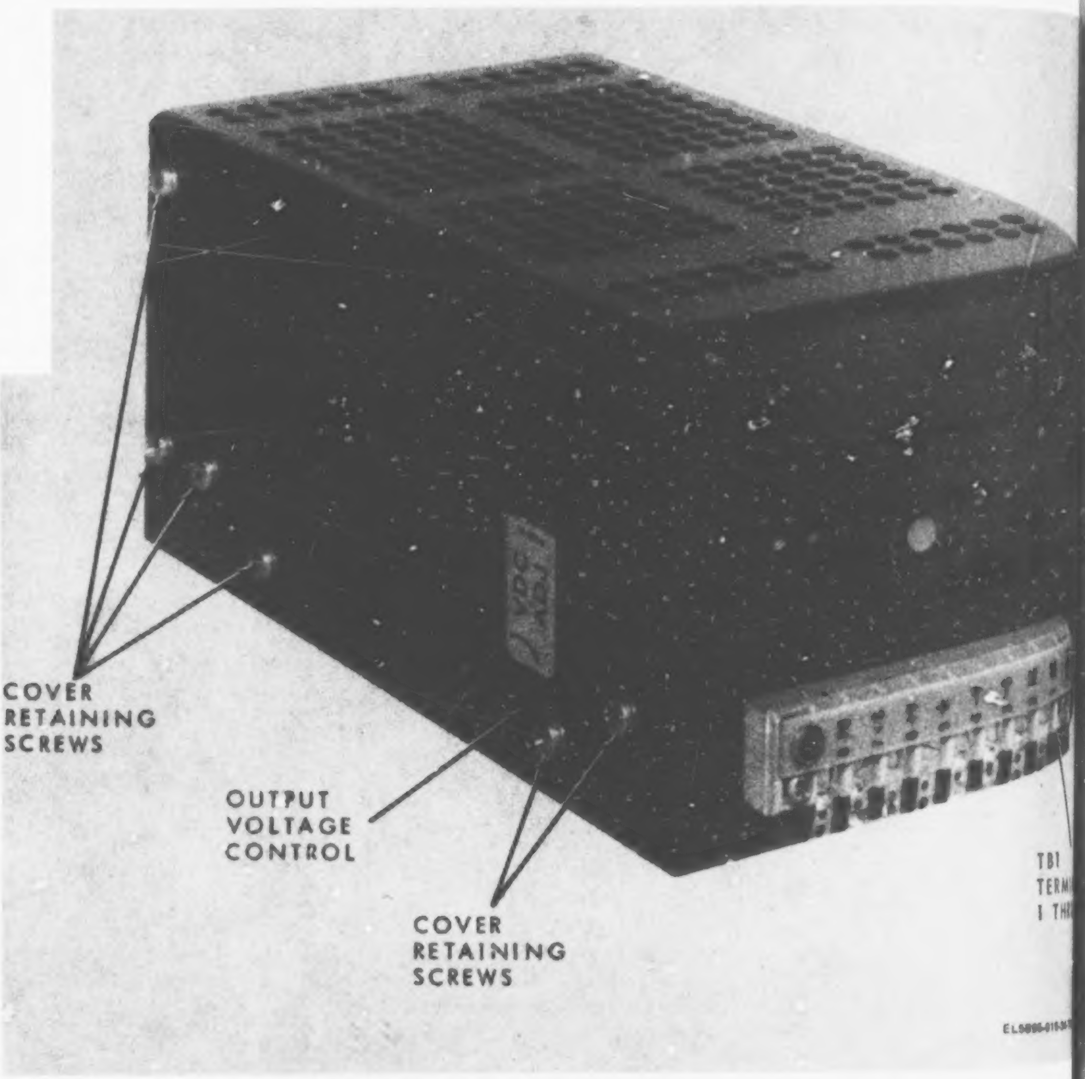
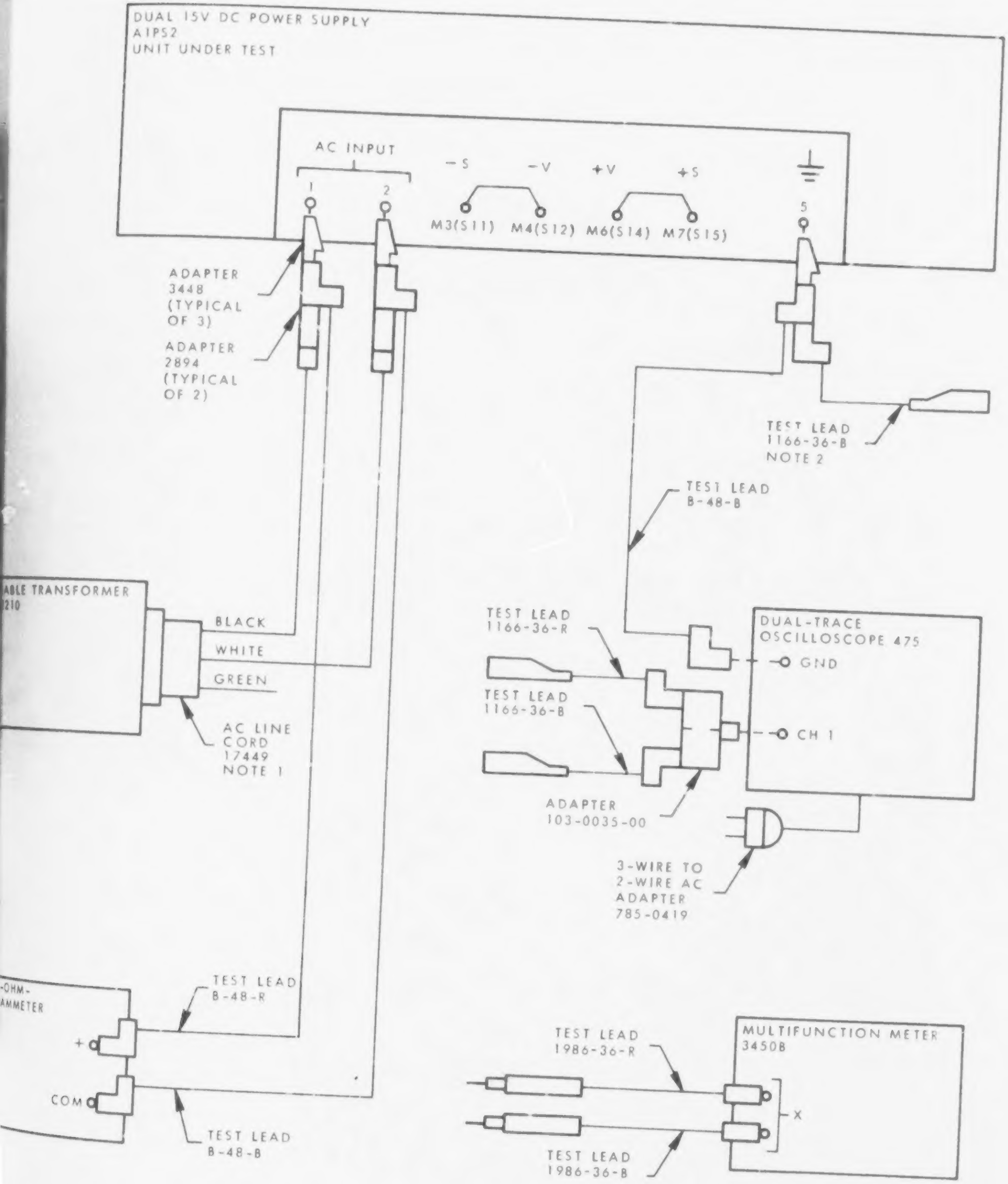

COVER RETAINING SCREWS
OUTPUT VOLTAGE CONTROL
COVER RETAINING SCREWS
TB1
TERM
1 THR
VDC ADJ
EL5895-915-3

Figure 3-24. +5 V dc power supply HTA-9A1PS1, parts location (sheet 4 of 4).


DUAL 15V DC POWER SUPPLY
A1PS2
UNIT UNDER TEST
AC INPUT
1
2
-S
-V
+V
+S
5
M3(S11)
M4(S12)
M6(S14)
M7(S15)
ADAPTER
3448
(TYPICAL
OF 3)
ADAPTER
2894
(TYPICAL
OF 2)
TEST LEAD
1166-36-B
NOTE 2
TEST LEAD
B-48-B
ABLE TRANSFORMER
210
BLACK
WHITE
GREEN
AC LINE
CORD
17449
NOTE 1
TEST LEAD
1166-36-R
TEST LEAD
1166-36-B
DUAL-TRACE
OSCILLOSCOPE 475
GND
CH 1
ADAPTER
103-0035-00
3-WIRE TO
2-WIRE AC
ADAPTER
785-0419
-OHM-
AMMETER
+
COM
TEST LEAD
B-48-R
TEST LEAD
B-48-B
TEST LEAD
1986-36-R
MULTIFUNCTION METER
3450B
X
TEST LEAD
1986-36-B

NOTES:
1. TAPE BACK GREEN WIRE.
2. CONNECT TO EARTH GROUND.

EL5895-915-34-TM-45

-25. *Dual 15 V dc power supply HTA-9A1PS2, troubleshooting and voltage adjustment, test setup diagram.*

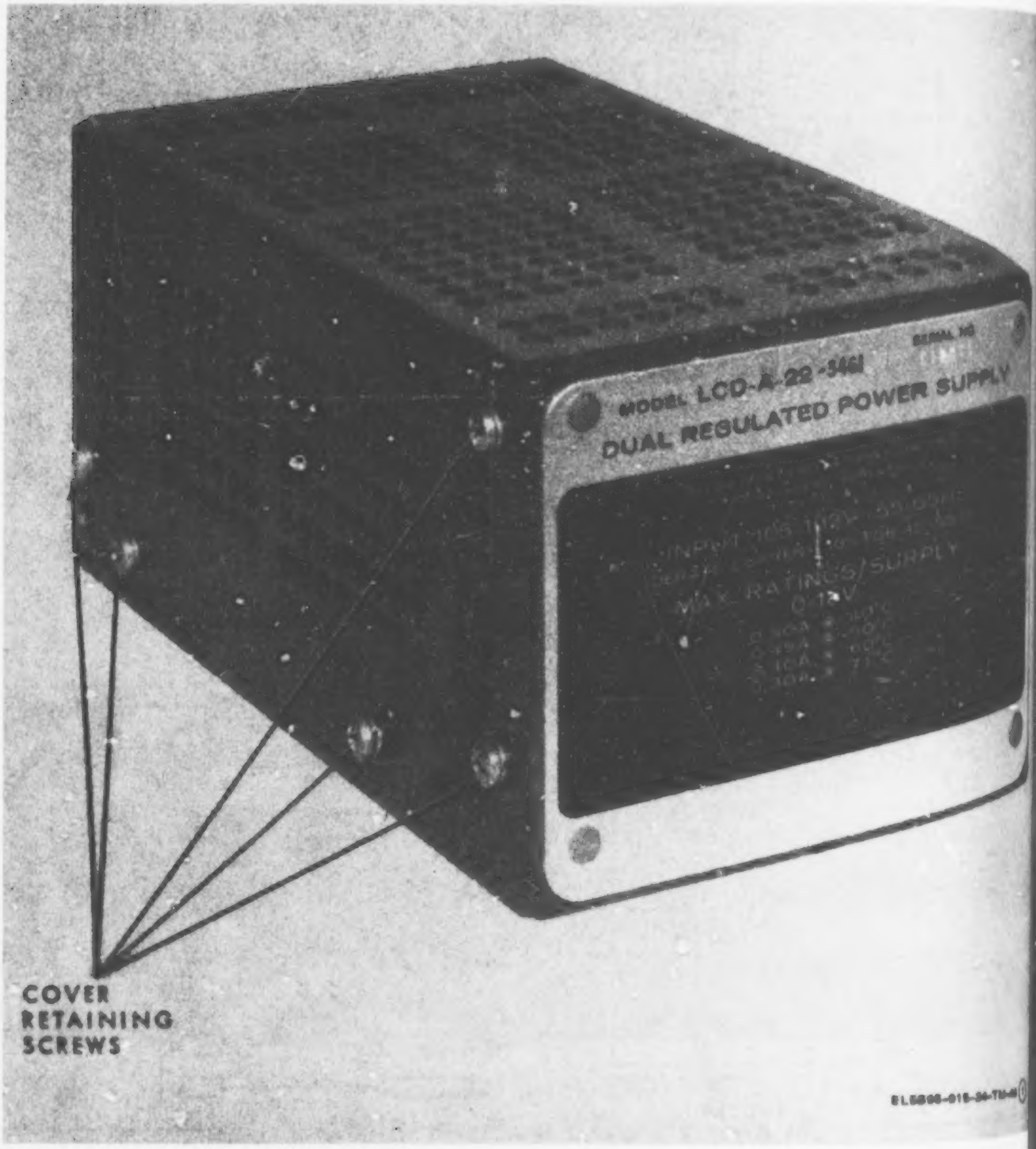

SERIAL NO
MODEL LCD-A-22-346I
DUAL REGULATED POWER SUPPLY
MAX RATINGS/SUPPLY
COVER RETAINING SCREWS

Figure 3-26. Dual 15 V dc power supply HTA-9A1PS2, parts location (sheet 1 of 5).

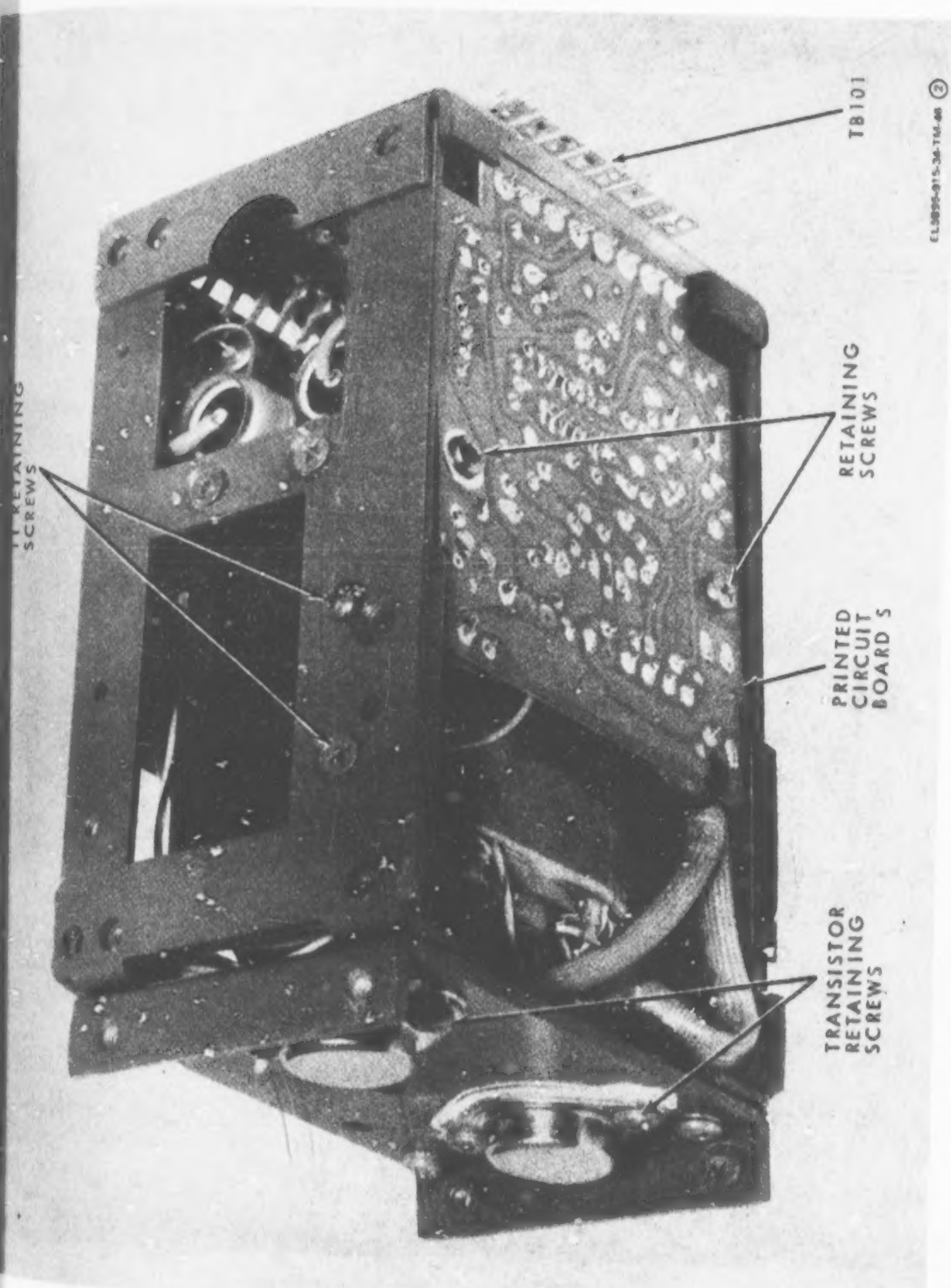

T1 RETAINING SCREWS
RETAINING SCREWS
TB101
PRINTED CIRCUIT BOARD 5
TRANSISTOR RETAINING SCREWS
EL5895-915-34-TM-48 ②

Figure 3-26. Dual 15 V dc power supply HTA-9A1PS2, parts location (sheet 2 of 5).

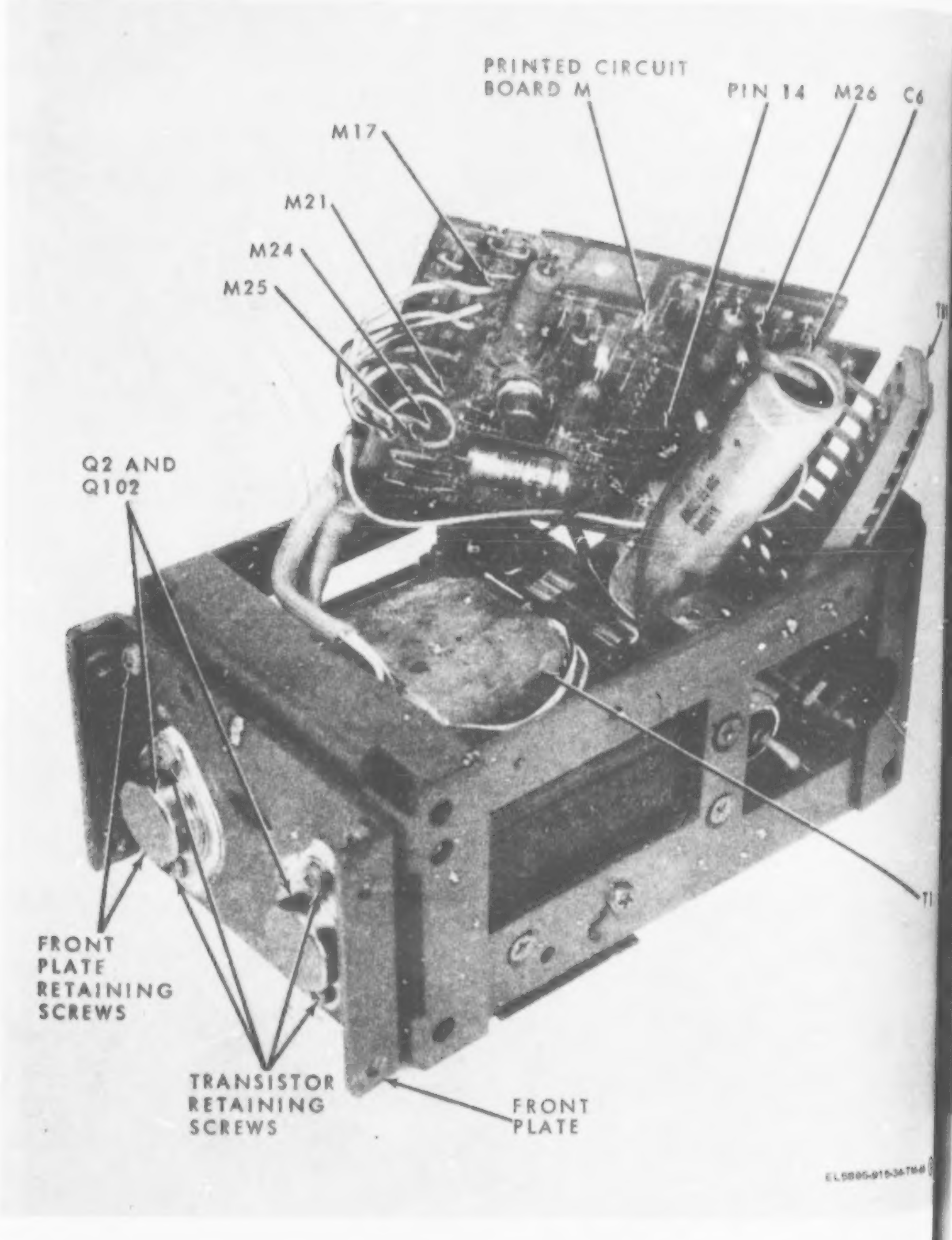

PRINTED CIRCUIT BOARD M
PIN 14
M26
C6
M17
M21
M24
M25
TB
Q2 AND Q102
T1
FRONT PLATE RETAINING SCREWS
TRANSISTOR RETAINING SCREWS
FRONT PLATE
EL5895-915-34TM-8

Figure 3-26. Dual 15 V dc power supply HTA-9A1PS2, parts location (sheet 3 of 5).

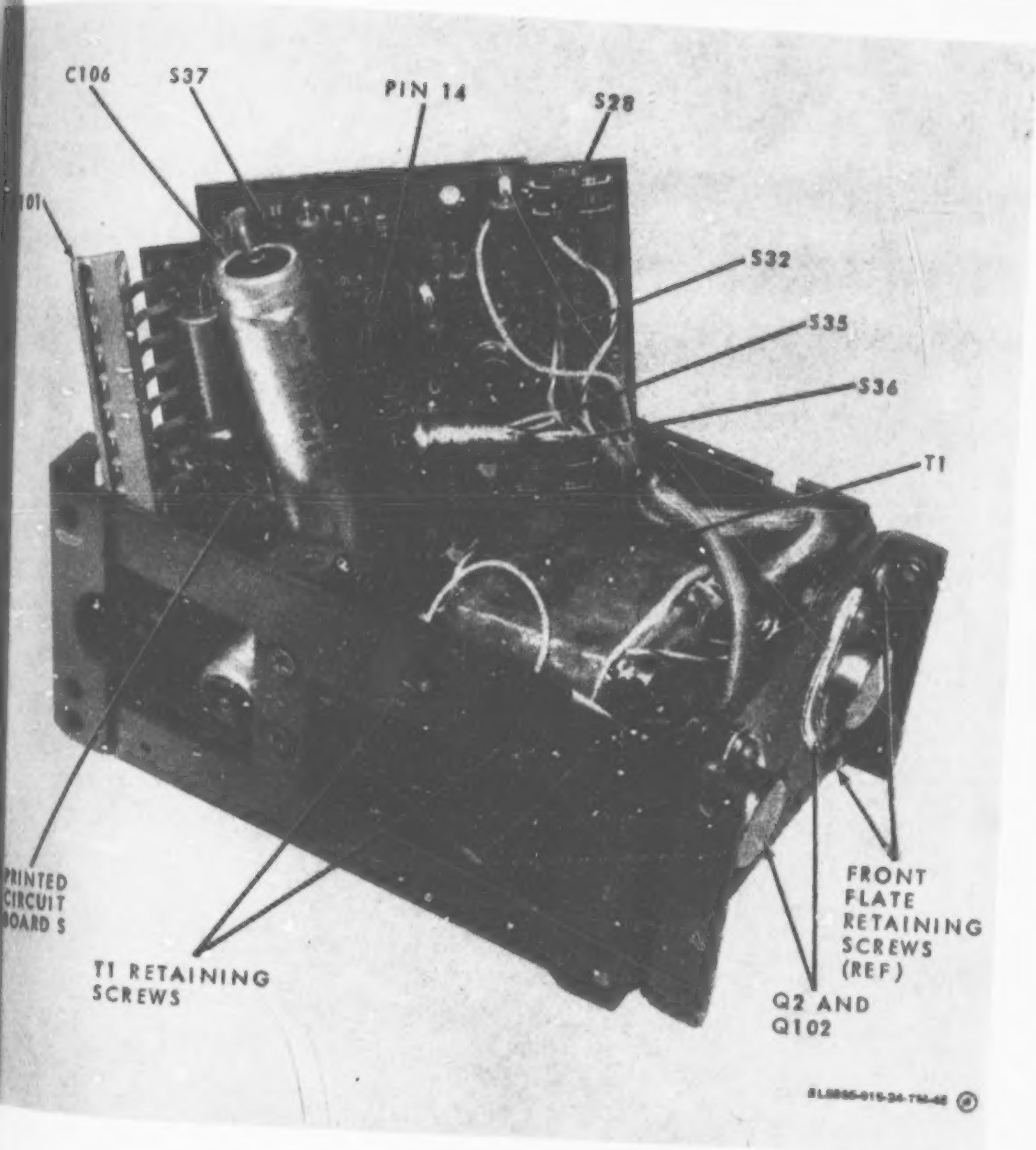

C106
S37
PIN 14
S28
101
S32
S35
S36
T1
PRINTED
CIRCUIT
OARD S
T1 RETAINING
SCREWS
FRONT
FLATE
RETAINING
SCREWS
(REF)
Q2 AND
Q102
EL5895-915-34-TM-48

Figure 3-26. Dual 15 V dc power supply HTA-9A1PS2, parts location (sheet 4 of 5).

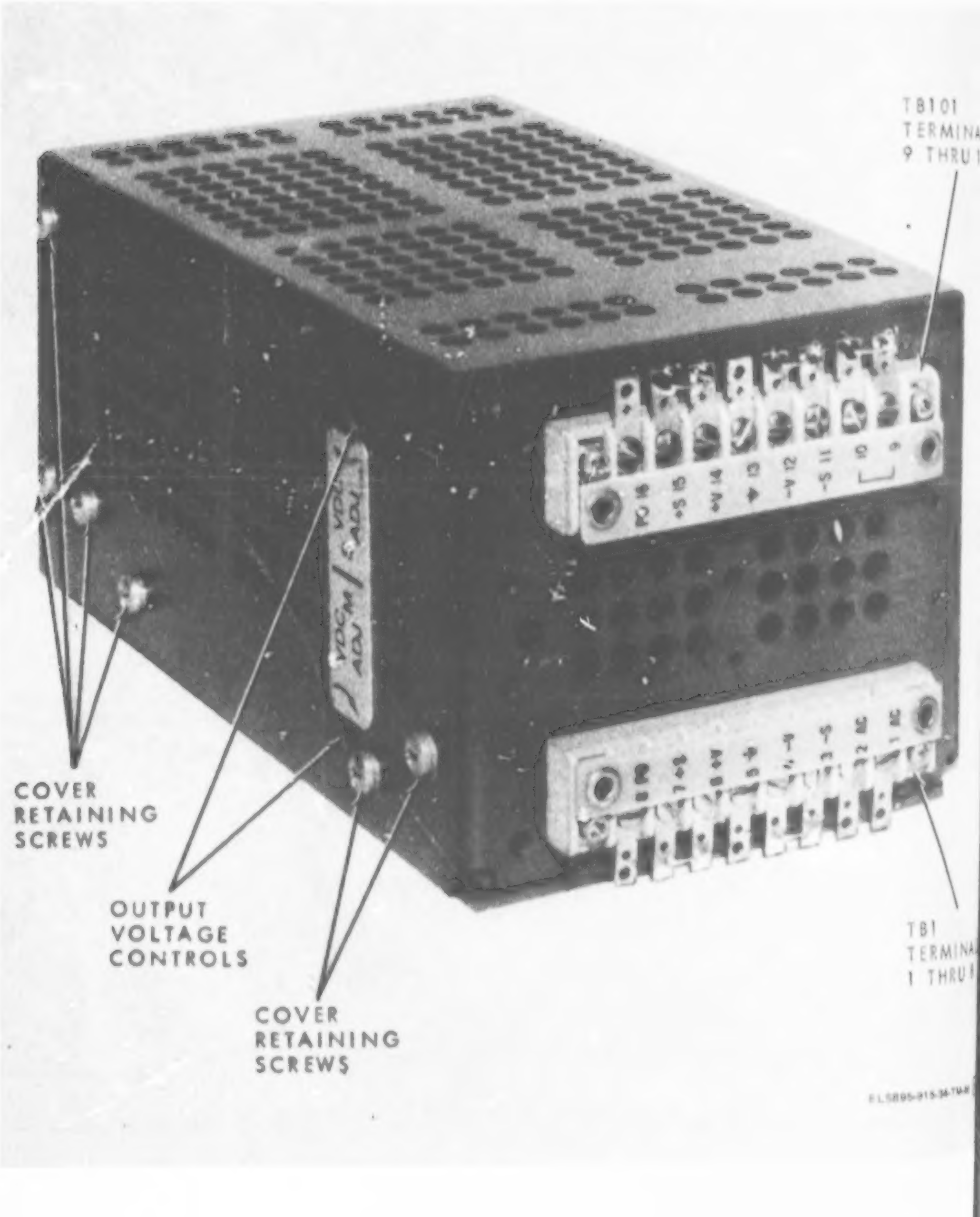
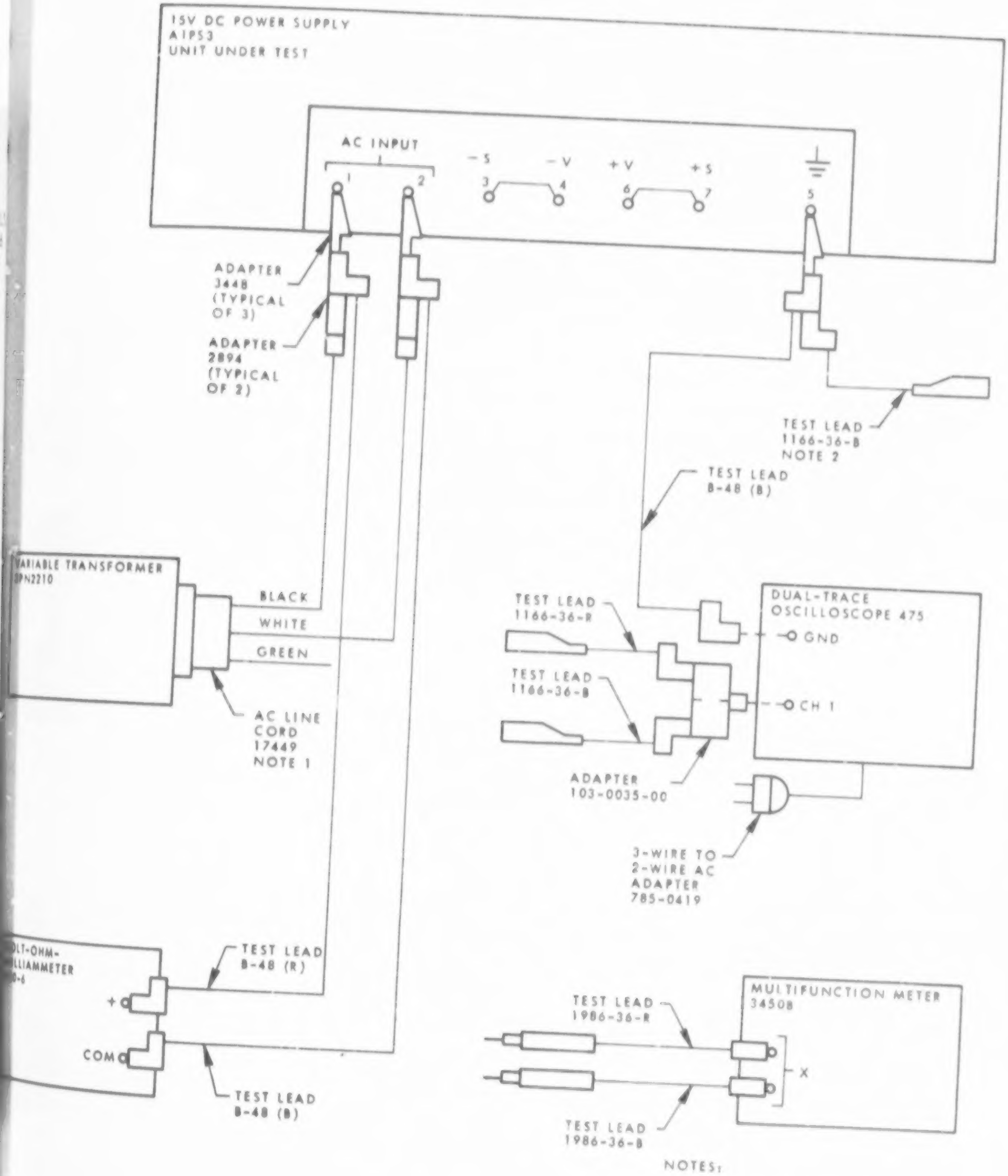

TB101
TERMINA
9 THRU 1
COVER
RETAINING
SCREWS
OUTPUT
VOLTAGE
CONTROLS
COVER
RETAINING
SCREWS
TB1
TERMINA
1 THRU
EL5895-915-34-TM-8

Figure 3-26. Dual 15 V dc power supply HTA-9A1PS2, parts location (sheet 5 of 5).


15V DC POWER SUPPLY
A1PS3
UNIT UNDER TEST
AC INPUT
1
2
– S
– V
+ V
+ S
3
4
6
7
5
ADAPTER
344B
(TYPICAL
OF 3)
ADAPTER
2894
(TYPICAL
OF 2)
TEST LEAD
1166-36-B
NOTE 2
TEST LEAD
B-48 (B)
ARIABLE TRANSFORMER
PN2210
BLACK
WHITE
GREEN
AC LINE
CORD
17449
NOTE 1
TEST LEAD
1166-36-R
TEST LEAD
1166-36-B
DUAL-TRACE
OSCILLOSCOPE 475
GND
CH 1
ADAPTER
103-0035-00
3-WIRE TO
2-WIRE AC
ADAPTER
785-0419
LT-OHM-
LLIAMMETER
0-6
+
COM
TEST LEAD
B-48 (R)
TEST LEAD
B-48 (B)
TEST LEAD
1986-36-R
TEST LEAD
1986-36-B
MULTIFUNCTION METER
3450B
X

NOTES:

1. TAPE BACK GREEN WIRE.
2. CONNECT TO EARTH GROUND.

EL5895-915-34-TM-47

ure 3-27. *+15 V dc gate power supply HTA-9A1PS3, troubleshooting and voltage adjustment, test setup diagram.*

WARNING

120 V ac is present in this equipment. Serious injury or death may result if normal precautions are not observed. Front panel circuit breakers do not completely isolate the 120 V ac; this voltage still exists as a potential hazard at the circuit breaker input terminals.

Table 3-22 15 V DC Power Supply HTA-9A1PS3 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Power transformer T1 main rectifier secondary	As specified in paragraph 3-38b.	Connect as specified in paragraph 3-38b with multifunction meter between terminal A13 and terminal A1.	23.1 ±0.2 V ac	Check C5 and C10 for shorted condition. Check T1 for open shorted condition. Check S1 f open condition. Replace fault item.
2	Main rectifier circuit	Multifunction meter: press DC FUNCTION switch.	Connect multifunction meter leads to power supply as follows: Test lead - Power supply -(blk) TB1-6 +(red) Term A12 on PC board A	10.5 ±1.1 V dc	Check R3, C3, C6, CR2 thru CR5, and Q4 for a shorted o open condition. Replace fau item.
3	Bias supply		Connect multifunction meter test leads to power supply as follows: Meter lead - Power supply -(blk) TB1-6 +(red) Pin 14 of integrated circuit IC1.	21 ±0.2 V dc	Check CR1, CR21, and C1 for shorted or open condition Re place faulty item.
4	Power transformer T1 auxiliary secondary	As specified in paragraph 3-38b.	Connect as specified in paragraph 3-38b with multifunction meter connected between terminal A8(+) and TB1-6(-) on PC board A.	-7.2 ±0.7 V dc	Check CR22 and IC1. Replac faulty item.
5	Series voltage regulator circuit		Connect multifunction meter test leads to power supply as follows: Meter lead - Power supply -(blk) TB1-4 +(red) TB1-6	15 ±0.75 V dc	a. If voltage is present but no within tolerance, adjust VDC control R8. If voltage cann adjusted with R8, check R8 shorted or open condition Re place if faulty. b. If R8 is not faulty, power may be operating as consta current source at current li value. Check integrated cir IC1 and series regulator ci

best copy available

pages tightly bound

Table 3-22 15 V DC Power Supply HTA-9A1PS3 Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
					with ohmmeter for shorted condition. Replace faulty item. c. If output voltage is too high, check R8 with ohmmeter for open condition. Check Q3, Q1, Q2, and Q4 for shorted condition. Check pin 8 on IC1 or CR21 for an open condition. Replace faulty item. d. If output voltage is zero, check F1. Replace if defective. If F1 blows immediately, check C7 and C15 for shorted condition. Replace defective item.
	Filter circuits	Twist oscilloscope test leads to cancel external noise signals when measuring ripple voltage.	Connect oscilloscope test leads to power supply as follows: Test lead Power supply -(blk) TB1-3 +(red) TB1-7	Equal to or less than 1 mV p-p ripple	a. If ripple is at the line frequency or twice the line frequency, check CR2 thru CR5 for a shorted or open condition. Check C1, C3, C6, and C10 for open conditions. Replace faulty item. b. If large spikes are present, check C5 for an open condition. c. If high ripple at frequency other than line or twice line frequency, check C2 and C7 for open, and C11 and R2 for short or open condition. Replace faulty item.

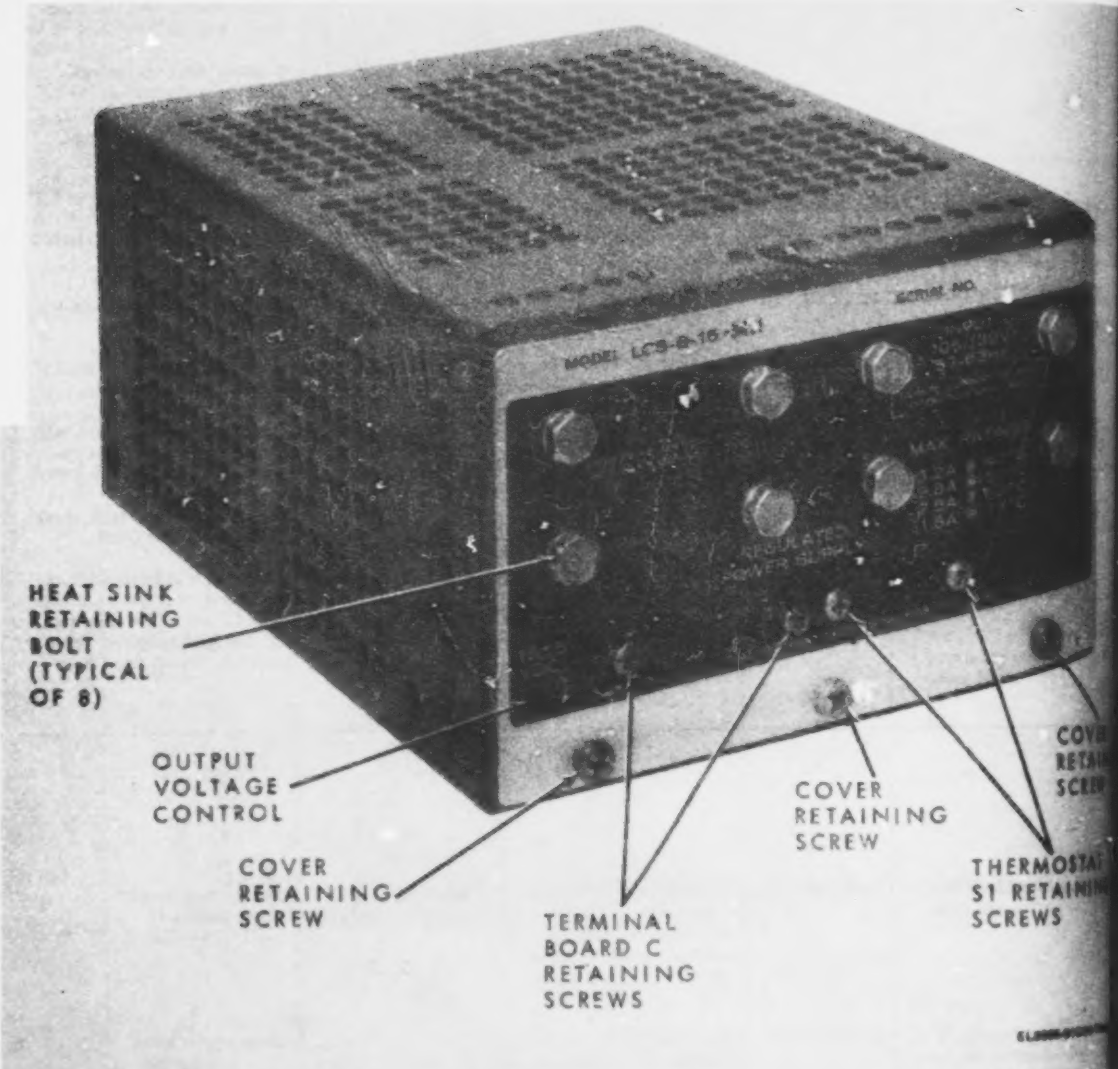

MODEL LCS-B-15-
SERIAL NO.
REGULATED POWER SUPPLY
HEAT SINK RETAINING BOLT (TYPICAL OF 8)
OUTPUT VOLTAGE CONTROL
COVER RETAINING SCREW
TERMINAL BOARD C RETAINING SCREWS
COVER RETAINING SCREW
THERMOSTAT S1 RETAINING SCREWS
COVE RETAI SCREW

Figure 3-28. +15 V dc gate power supply HTA-9A1PS3, parts location (sheet 1 of 6).

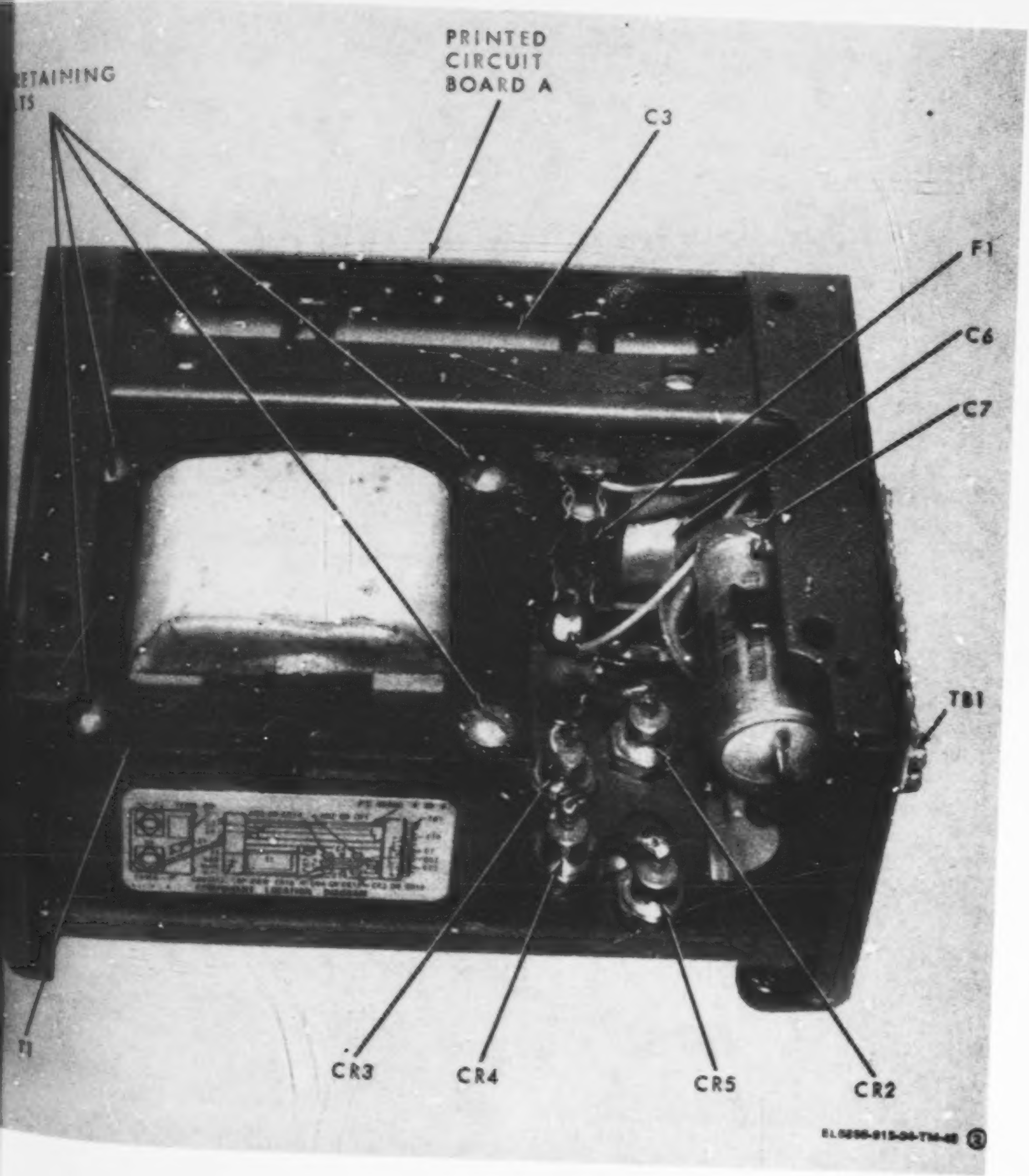

ETAINING
TS
PRINTED
CIRCUIT
BOARD A
C3
F1
C6
C7
TB1
T1
CR3
CR4
CR5
CR2
EL5895-915-34-TM-48 ②

Figure 3-28. +15 V dc gate power supply HTA-9A1PS3, parts location (sheet 2 of 6).

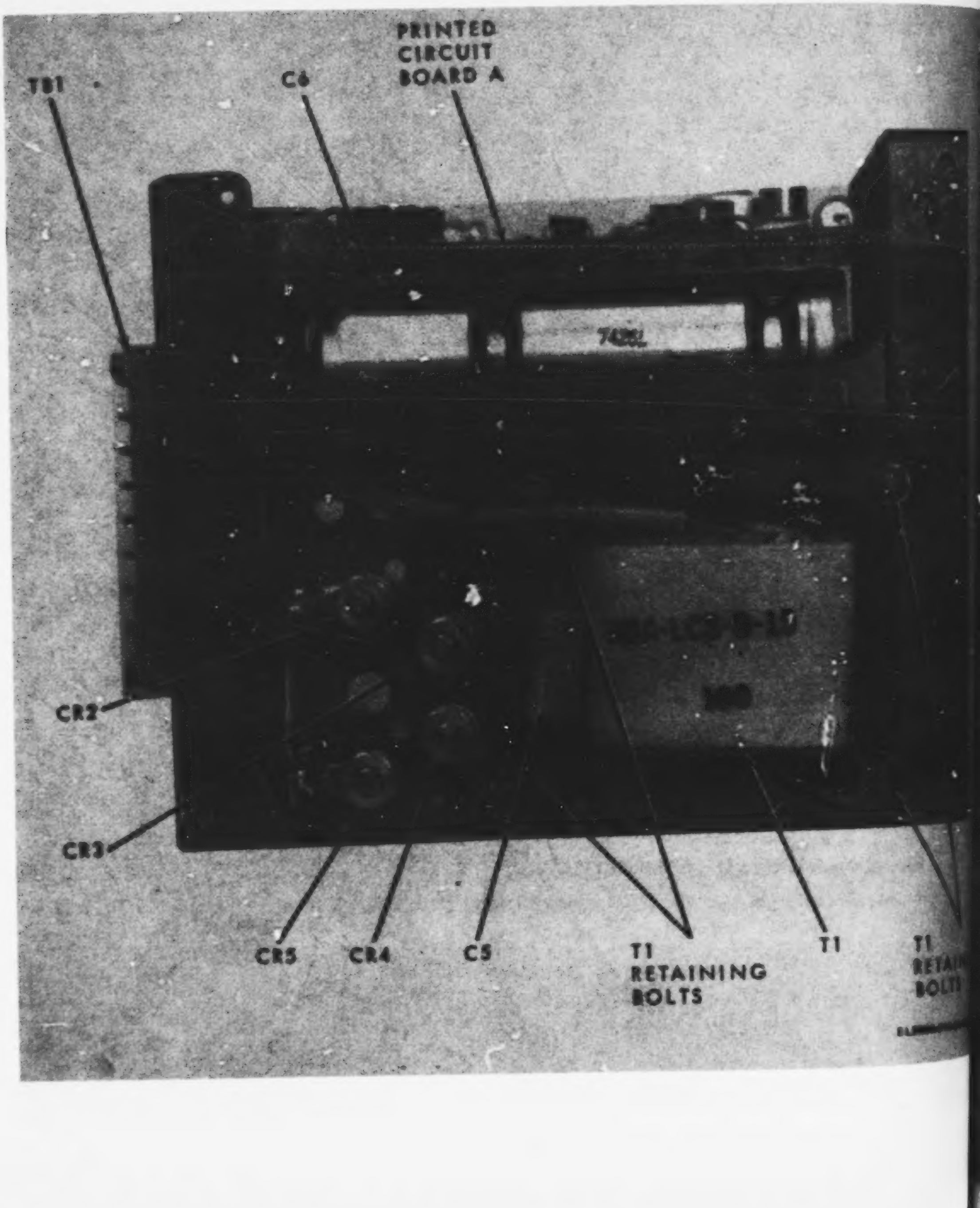

PRINTED CIRCUIT BOARD A
TB1
C6
CR2
CR3
CR5
CR4
C5
T1 RETAINING BOLTS
T1
T1 RETAI BOLT

Figure 3-28. +15 V dc gate power supply HTA-9A1PS3, parts location (sheet 3 of 6).

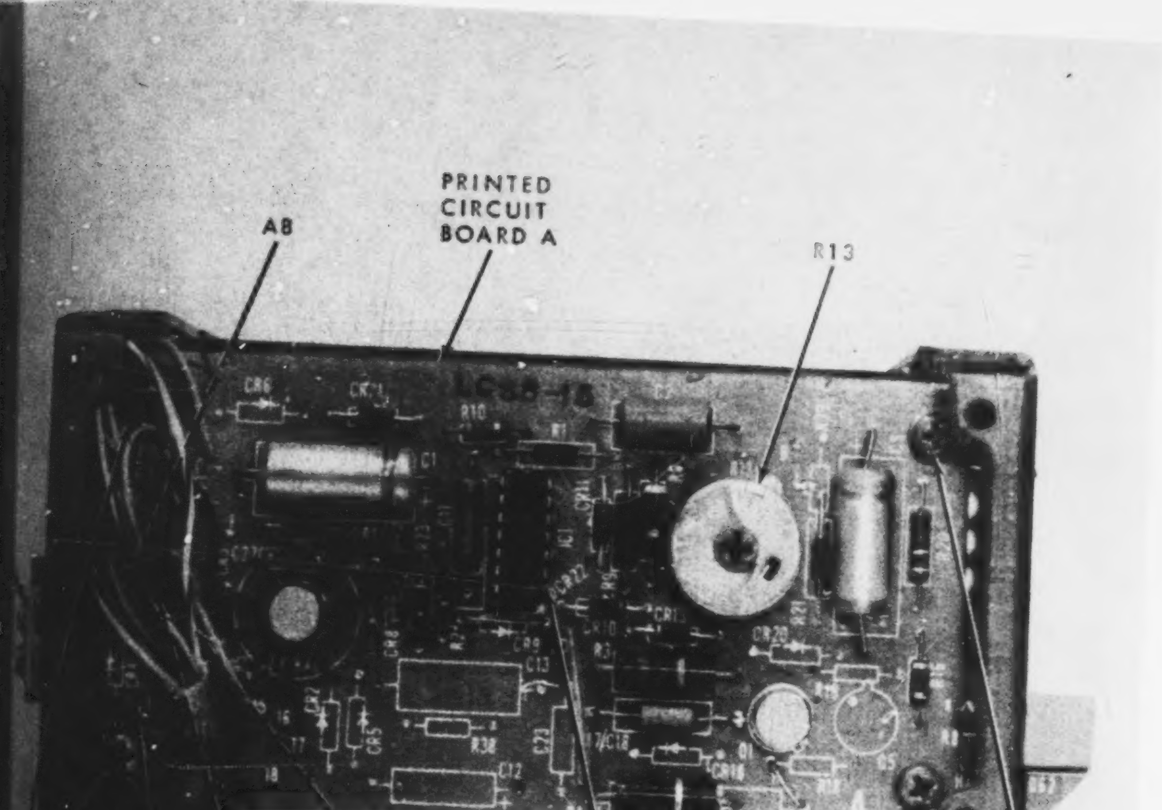

PRINTED CIRCUIT BOARD A
A8
R13
A1
A12
A13
PIN 14
PC BOARD RETAINING SCREWS
OARD
INING
WS
EL5895-915-34-TM-48 ④

Figure 3-28. +15 V dc gate power supply HTA-9A1PS3, parts location (sheet 4 of 6).

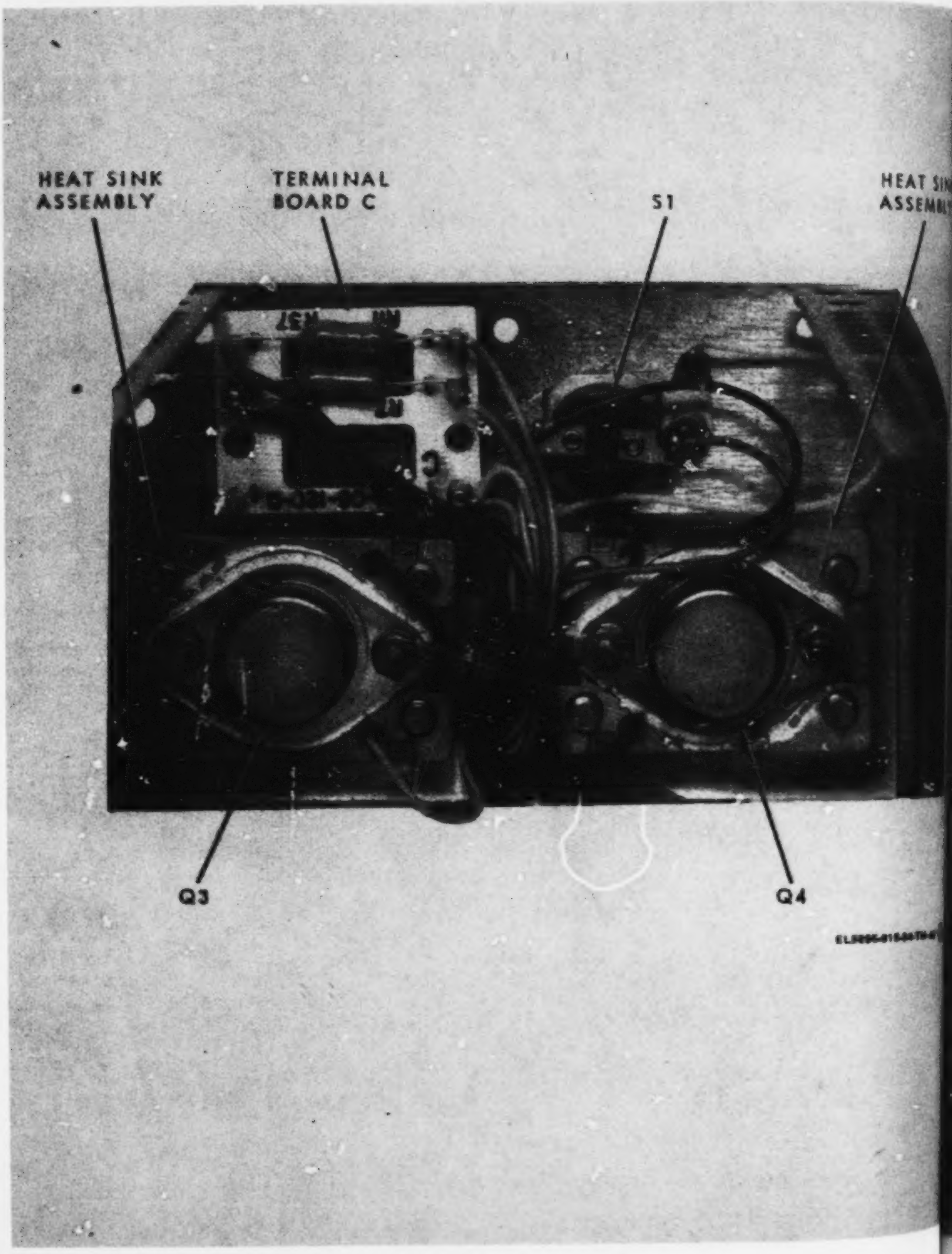

HEAT SINK ASSEMBLY
TERMINAL BOARD C
S1
HEAT SIN
ASSEMBL
Q3
Q4

Figure 3-28. +15 V dc gate power supply HTA-9A1PS3, parts location (sheet 5 of 6).

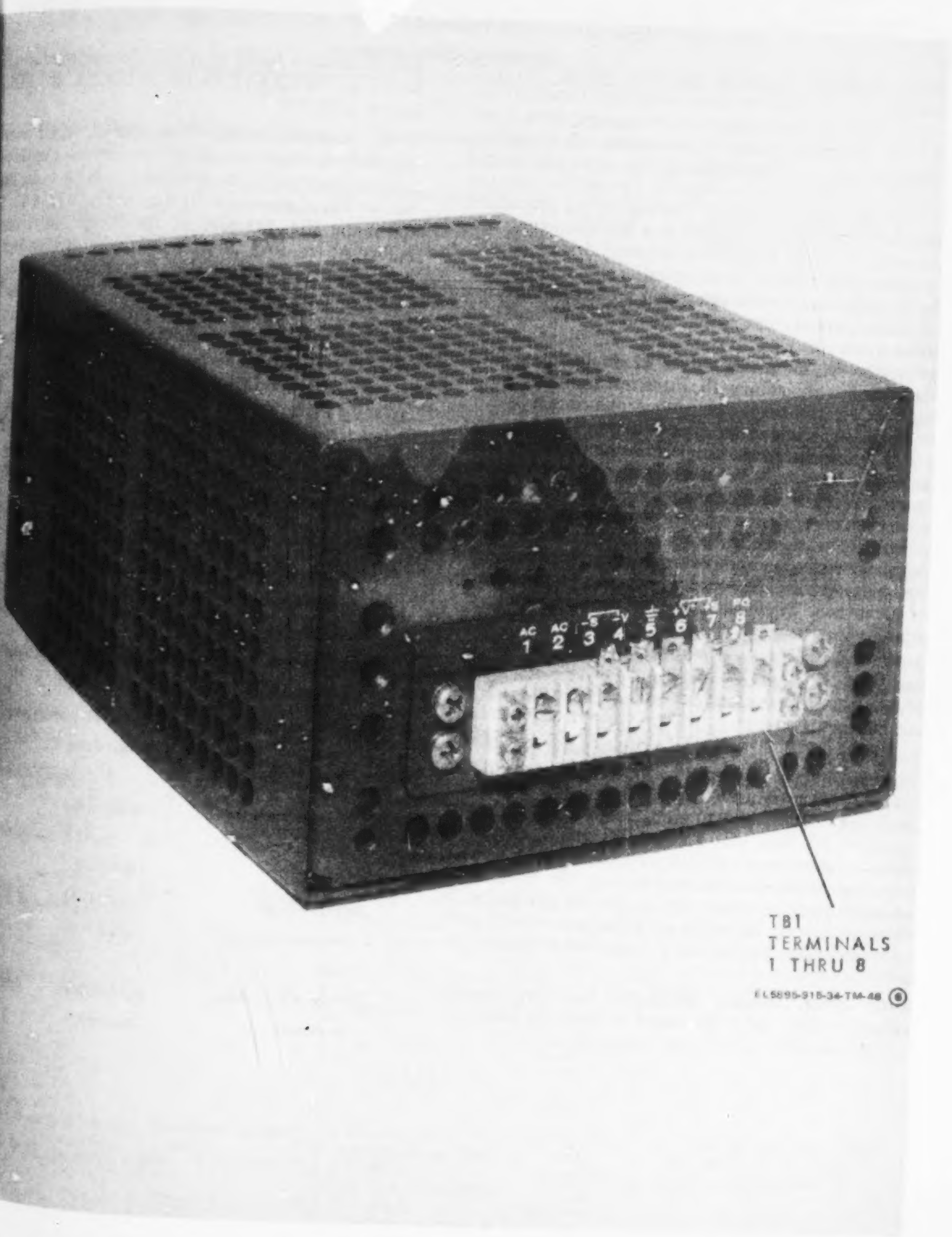

AC 1
AC 2
-S 3
-V 4
5
+V 6
+S 7
PC 8
TB1 TERMINALS 1 THRU 8
EL5895-915-34-TM-48

Figure 3-28. +15 V dc gate power supply HTA-9A1PS3, parts location (sheet 6 of 6).

SECTION VIII. TROUBLESHOOTING OF ANTENNA ANCILLARY GROUP HTA-12

3-39. General. Antenna ancillary group HTA-12 consists of azimuth drive motor assemblies 1 and 2 HTA-12A1, 12A3 and elevation drive motor assemblies 1 and 2 HTA-12A2, 12A4. Fault localization to an azimuth or elevation axis is accomplished by the servo and control equipment group test in section II. This section contains preliminary procedures and troubleshooting procedures necessary for fault localization to a malfunctioning subassembly of either azimuth or elevation drive motor assemblies after referral by organizational maintenance or by the servo and control equipment group test in section II. Each antenna drive motor assembly consists of a dc drive motor B1, electric disk brake A1, dc tachometer-generator G1, and motor blower B2. Preliminary procedures consist of obtaining the listed test equipment, making the prescribed test connections, and initially setting equipment controls to specified settings. These settings, and all subsequent settings given in the troubleshooting procedure, must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement or repair of a malfunctioning assembly or component, refer to section XVI in this chapter for the replacement or repair procedure. When a troubleshooting procedure specifies replacement or repair of an assembly or component by higher level maintenance, notify the appropriate personnel.

3-40. Test Equipment and Materials. The only test equipment required to troubleshoot a drive motor assembly consists of vom 260-6 and two test leads 1986-36 (one red and one black).

3-41. Test Connections and Conditions (fig. 3-29). Troubleshooting of an azimuth or elevation drive motor assembly is performed with both drive motor assemblies in an operational configuration except where otherwise specified. All tests and observations are performed at direct current control HTA-9 terminal boards and frontmounted circuit card assemblies or at the drive motor assembly junction boxes. Set up the test equipment as shown in figure 3-29, but do not make any connections to test points. Test connections are specified in the troubleshooting table.

3-42. Initial Control Settings. Set vom function switch to +DC and range switch to 50 V. On electronic control amplifier circuit card assembly A2A1 (for suspected azimuth fault) or A3A1 (for suspected ele fault), set OPERATE switch to LOCAL and LOC switch to SLEW.

3-43. Troubleshooting Procedures. After com ing the preliminary procedures, perform the steps in 3-23 as specified by the symptom/probable cause li below. The electronic control amplifier HTA-9A2 schematic (fig. FO-20) and the circuit card asse HTA-9A2A1, 9A3A1 schematic (fig. FO-21) an drive motor assembly 1 and 2 schematic (fig. 2-8) assist in performing the troubleshooting procedure fer to figure 3-30 for parts location. When a fau been isolated to drive motor assembly dc drive m refer to higher level maintenance. Repair the other assemblies as specified in the troubleshooting table a faulty assembly has been replaced, perform the formance test procedures described in section XXX this chapter. Upon satisfactory completion of the formance test, the antenna drive assembly can b turned to service.

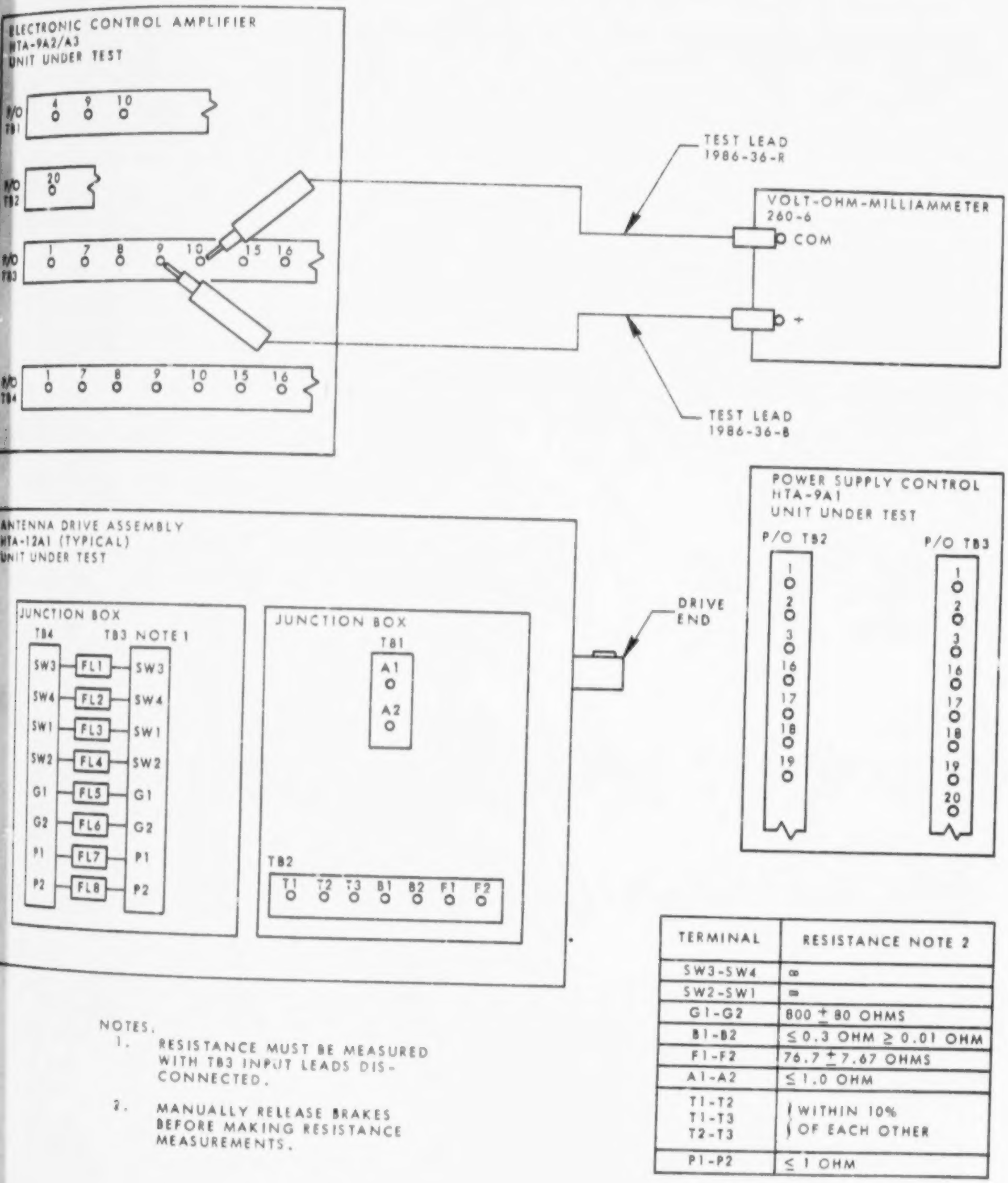
Symptom	Probable cause
Antenna slews erratically in one in the other direction.	Faulty tachometer. Refer to step 1 in table 3-23.
AZ MOTOR HOT indicator on antenna position and status panel is lit (red).	a. Faulty azimuth blowe Refer to step 2. b. Faulty azimuth moto Refer to step 5.
EL MOTOR HOT indicator on antenna position and status panel is lit (red).	a. Faulty elevation blow Refer to step 4. b. Faulty elevation moto Refer to step 3.
Antenna will not rotate on elevation axis.	El brake faulty. Refer step 6.
Antenna will not rotate on azimuth axis.	Az brake faulty. Refe to step 7.

Table 3-23 Az-E1 Drive Motor Assemblies HTA-12A1, 12A2, 12A3, 12A4 Troubleshooting Procedures

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	Dc tachometer generator G1; elevation antenna drive assembly no. 1, elevation antenna drive assembly no.2, azimuth antenna drive assembly no. 1, azimuth antenna drive assembly no. 2.	SLEW control set to full travel in indicated direction.	(Refer to figure 3-20.) a. Connect vom to TB3-9 and TB3-10 (9A2). b. Connect vom TB4-9 and TB4-10 (9A2). c. Connect vom to TB3-9 and TB3-10 (9A3). d. Connect vom to TB4-9 and TB4-10 (9A3).	+175 +17.5 V dc (nom)	If indication is abnormal, replace faulty dc tachometer-generator. (Refer to section XVI.)
	Az motor blower B2; an tenna drive assembly no. 1, antenna drive assembly no. 2.		Connect vom to TB3-1 and TB3-16 (9A1), TB3-2 and TB-16 (9A1); and TB3-3 and TB3-16.	120 V ac max	If indication is abnormal, replace faulty motor blower B2. (Refer to section XVI.)
	EL dc drive motor B1; antenna drive assembly no. 1, antenna drive assembly no. 2.		Connect vom to TB1-4 and TB4-1 (9A2).	+26 +2.6 V dc	If indication is abnormal, refer to higher level maintenance.
	El motor blower B2; antenna drive assembly no. 2		Connect vom to TB2-1 and TB2-16 (9A1); Tb2-2 and TB22-16 (9A1); TB2-3 and TB2-16 (9A1); TB2 (El motor no. 2 J-box) T1 and T2; and T2 and T3.	120 V ac max	If indication is abnormal, replace faulty motor blower B2. (Refer to section XVI.)
	Az dc drive motor B1; an tenna drive assembly no. 1. Az dc drive motor B1, an tenna drive assembly no. 2.		a. Connect vom to TB1-4 and TB3-1 (9A3). b. Connect vom to TB1-4 and TB1-1 (9A3).	a. +26 +2.6 V dc b. +26 +2.6 V dc	a. If indication is abnormal, refer to higher level maintenance b. If indication is abnormal, refer to higher level maintenance.
	El electric disk brake A1, an tenna drive assembly no. 1		a. Connect vom to: (1) TB2-20 and TB1-4 (9A3) (2) TB3-16 and TB1-4 (9A3) (3) TB2-4 and TB2-5 (9A1) (4) TB2 (E1 motor no. 1 J-1 box) B2 and B1	(1) +26 +2.6 V dc (2) +26 +2.6 V dc (3) 208 V ac min (4) 208 V ac min	a. If AMP ON (DS17) is lit and MNL BRK RLSE (DS1) is not lit, replace faulty disk brake A1. (Refer to section XVI.)
	El electric disk brake A1, antenna drive assembly no. 2	Operational configuration	b. Connect vom to: (1) TB2-20 and TB1-4 (9A3) (2) TB4-15 and TB1-4 (9A3) (3) TB2-5 and TB3-5 (9A1) (4) TB2 (Az motor no. 1 J-box) B2 and B1	(1) +26 ±2.6 V dc (2) +26 ±2.6 V dc (3) 208 V ac min (4) 208 V ac min	b. If AMP ON (DS17) and MNL BRK RLSE (DS19) is not lit, replace faulty disk brake A1.

Table 3-23 Az-El Drive Motor Assemblies HTA-12A1, 12A2, 12A3, 12A4 Troubleshooting Procedures - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
7	Az electric disk brake A1, antenna drive assembly no. 1	Operational configuration	a. Connect vom to: (1) TB2-20 and TB1-4 (9A2) (2) TB3-16 and TB11-4 (9A2) (3) TB33-4 and TB3-5 (9A1) (4) TB2 (Az motor no. 1 J-box) B2 and B1	(1) +26 ±2.6 V dc (2) +26 ±26 V dc (3) 208 V ac min (4) 208 V ac min	a. If AMP ON (DS17) is lit an MNL BRK RLSE (DS19) is lit replace faulty disk brake (Refer to section XVI.)
	Az electric disk brake A1, antenna drive assembly no. 2	Operational configuration	b. Connect vom to: (1) TB2-20 and TB1-4 (9A3) (2) TB4-15 and TB1-4 (9A3) (3) TB3-4 and TB3-5 (9A1) (4) TB2 (Az motor no. 2 J-box) B2 and B1	(1) +26 ±2.6 V dc (2) +26 ±2.6 V dc (3) 208 V ac min (4) 208 V ac min	b. If AMP ON (DS17) is lit an MNL BRK RLSE (DS19) is lit, replace faulty disk brake (Refer section XVI.)


ELECTRONIC CONTROL AMPLIFIER
HTA-9A2/A3
UNIT UNDER TEST
P/O TB1
4 9 10
P/O TB2
20
P/O TB3
1 7 8 9 10 15 16
P/O TB4
1 7 8 9 10 15 16
TEST LEAD
1986-36-R
VOLT-OHM-MILLIAMMETER
260-6
COM
+
TEST LEAD
1986-36-B
POWER SUPPLY CONTROL
HTA-9A1
UNIT UNDER TEST
P/O TB2
1 2 3 16 17 18 19
P/O TB3
1 2 3 16 17 18 19 20
ANTENNA DRIVE ASSEMBLY
HTA-12A1 (TYPICAL)
UNIT UNDER TEST
JUNCTION BOX
TB4
TB3 NOTE 1
SW3 FL1 SW3
SW4 FL2 SW4
SW1 FL3 SW1
SW2 FL4 SW2
G1 FL5 G1
G2 FL6 G2
P1 FL7 P1
P2 FL8 P2
JUNCTION BOX
TB1
A1
A2
TB2
T1 T2 T3 B1 B2 F1 F2
DRIVE END

TERMINAL	RESISTANCE NOTE 2
SW3-SW4	∞
SW2-SW1	∞
G1-G2	800 ± 80 OHMS
B1-B2	≤ 0.3 OHM ≥ 0.01 OHM
F1-F2	76.7 ± 7.67 OHMS
A1-A2	≤ 1.0 OHM
T1-T2 T1-T3 T2-T3	WITHIN 10% OF EACH OTHER
P1-P2	≤ 1 OHM

NOTES.

1. RESISTANCE MUST BE MEASURED WITH TB3 INPUT LEADS DISCONNECTED.
2. MANUALLY RELEASE BRAKES BEFORE MAKING RESISTANCE MEASUREMENTS.

EL5895-915-34-TM-49

Figure 3-29. Drive motor assembly HTA-12A1, 12A2, 12A3, 12A4, troubleshooting, test setup diagram.

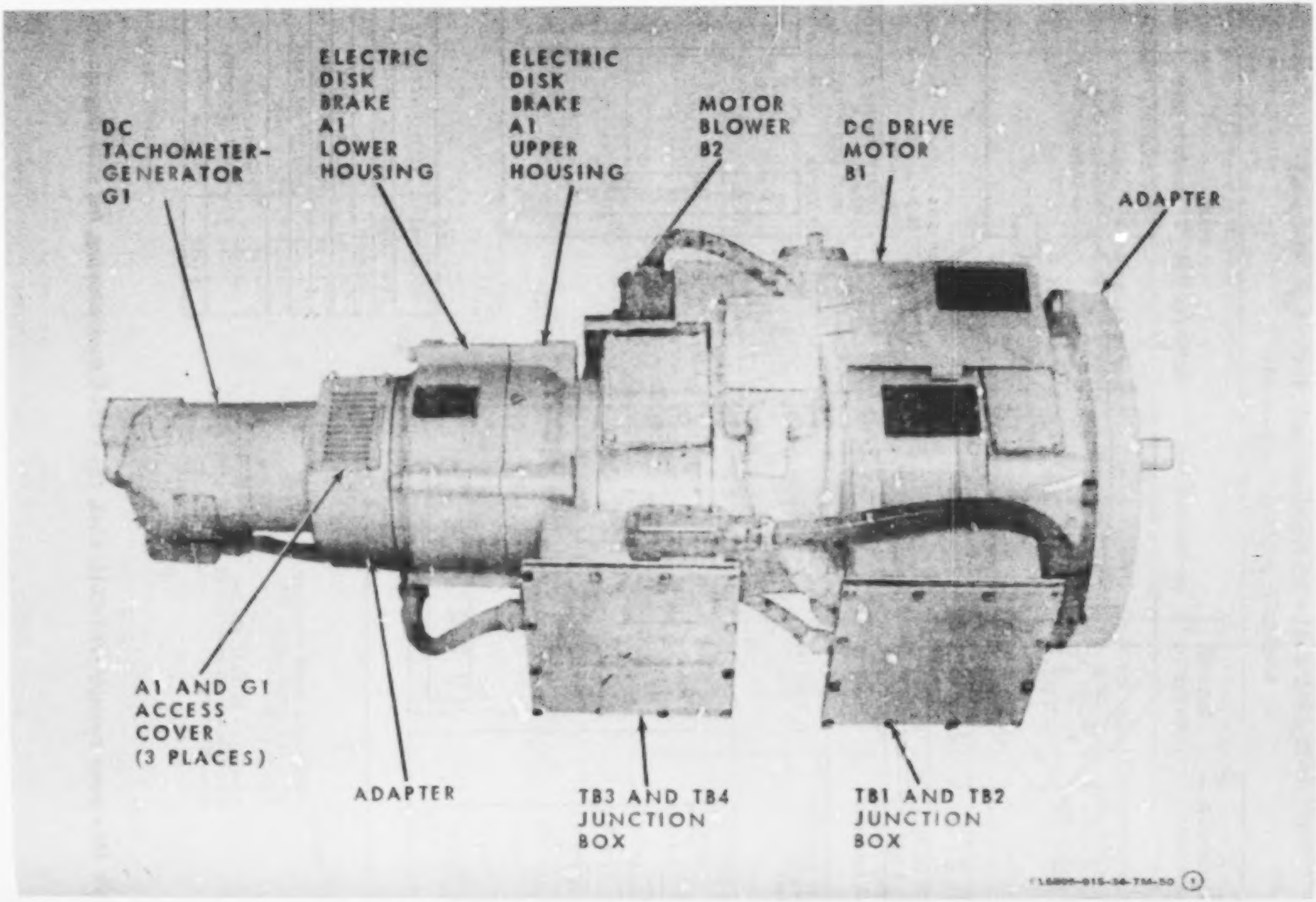

DC TACHOMETER-GENERATOR G1
ELECTRIC DISK BRAKE A1 LOWER HOUSING
ELECTRIC DISK BRAKE A1 UPPER HOUSING
MOTOR BLOWER B2
DC DRIVE MOTOR B1
ADAPTER
A1 AND G1 ACCESS COVER (3 PLACES)
ADAPTER
TB3 AND TB4 JUNCTION BOX
TB1 AND TB2 JUNCTION BOX
TL5895-915-34-TM-50 (1)

Figure 3-30. Drive motor assembly HTA-12A1, 12A2, 12A3, 12A4 parts location (sheet 1 of 2).

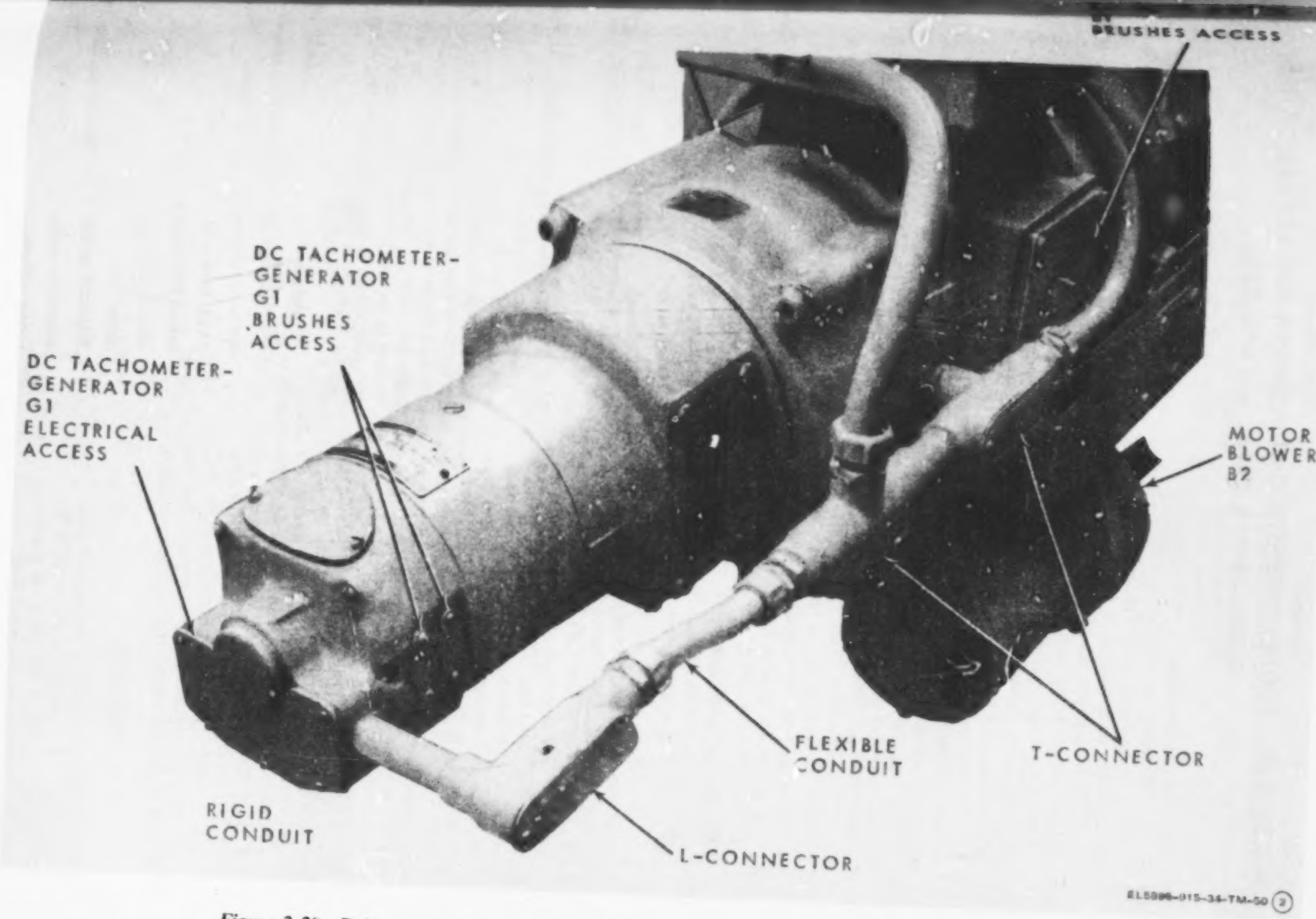

BRUSHES ACCESS
DC TACHOMETER-GENERATOR G1 BRUSHES ACCESS
DC TACHOMETER-GENERATOR G1 ELECTRICAL ACCESS
MOTOR BLOWER B2
RIGID CONDUIT
FLEXIBLE CONDUIT
T-CONNECTOR
L-CONNECTOR
EL5895-915-34-TM-50 ②

Figure 3-30. Drive motor assembly HTA-12A1, 12A2, 12A3, 12A4 parts location (sheet 2 of 2).

SECTION IX. TROUBLESHOOTING OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 and HTA-6A6A1

3-44. General. This section contains preliminary procedures and troubleshooting procedures necessary for fault localization to a malfunctioning synchro or limit switch in either azimuth data module or elevation data module after referral by organizational maintenance or from the servo and control group test in section II. The group test will isolate a data module fault to either the azimuth or elevation data module. Preliminary procedures consist of obtaining the listed test equipment, making prescribed test connections, and initially setting equipment controls to specified settings. These settings, and all subsequent settings given in the troubleshooting procedures must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies replacement or adjustment of a malfunctioning assembly or component at the maintenance level, refer to section XVII in this chapter for replacement or repair procedure. When a troubleshooting procedure specifies replacement or adjustment of an assembly or component by higher level maintenance, notify the appropriate personnel.

3-45. Test Equipment and Materials. The only test equipment required for troubleshooting the azimuth or elevation data module is a 260-6 vom. Test leads are supplied with the vom.

3-46. Test Connections and Conditions (fig. 3-31). Troubleshooting of the azimuth or elevation data module is performed with the equipment connected in the operational configuration. All wires from the data modules are routed through distribution box HTA-8A25. All voltages and resistance measurements shall be made by connecting the vom to the distribution box terminal board pins (test points) as shown in figure 3-31 and as specified in the troubleshooting table. Two persons are required to perform the troubleshooting procedure; one at direct current control HTA-9, the other at distribution box HTA-8A25.

3-47. Initial Control Settings. The data module is a passive device, slaved to antenna movements by gears contained within each data module. The data module for either axis monitors antenna position and limits when the antenna is in an operational mode. With the servo and control equipment in the manual mode, OPERATE switches S2 on electronic control amplifiers HTA-9A2 (elevation) and 9A3 (azimuth) are energized. Set test equipment and direct current control switches as follows.

CAUTION

The antenna may drift in the azimuth axis when the local switch is set to SLEW. Maintain control at all times to prevent antenna drift into an electrical limit.

NOTE

When either data module senses an electrical limit, the local enable signal from the antenna position and status panel to the direct current control goes from +26 to 0 V dc and both OPERATE switches are disabled. To back the antenna out of an electrical limit, it is necessary to use the handcrank(s) on azimuth or elevation gear boxes HTA-2A8, 2A9 or HTA-2A3A1, 2A3A2.

Control	Position
Vom	
Function	AC
Range	250 V
Direct current control	
OPERATE switch	LOCAL
LOCAL switch	SLEW
SLEW control	As indicated in the troubleshooting table

3-48. Troubleshooting Procedures. After co ing the preliminary procedures, perform the steps i 3-24 as specified by the symptom/probable cause below. The data module schematic (fig. 2-9) will as performing the troubleshooting procedures. Refer t ure 3-32 for parts location. After the faulty item ha replaced, perform the performance test procedur scribed in section XXXIV of this chapter. Upon sa tory completion of the performance test, the data m can be returned to service.

Symptom	Probable ca
AZIMUTH position indicator on antenna position and status panel does not follow antenna movement about the azimuth axis.	Azimuth data module synch B3 is faulty. Refer t step 1.
ELEVATION position indicator on antenna position and status	Elevation data module syn B3 is faulty. Refer t step 2.

Symptom	Probable cause
panel does not follow antenna movement about the elevation axis.	
AZIMUTH position indicator on antenna control panel does not follow antenna movement about the azimuth axis.	Azimuth data module synchro B1 or B2 is faulty. Refer to step 3 and 5.
ELEVATION position indicator on antenna control panel does not follow antenna movement about the elevation axis.	Elevator data module synchro B1 or B2 is faulty. Refer to steps 4 and 6.
AZ SERVO LIMIT or EL SERVO LIMIT indicator on antenna control panel is lit (amber).	Limit switch S1 in azimuth or elevation data module is faulty. Refer to step 7 and 8.
AZ ELECT LIM!T or EL ELECT LIMIT indicator on antenna position and status panel is lit (red).	Limit switch S1 in azimuth or elevation data module is faulty. Refer to steps 7 and 8.
Low elevation cutoff signal sensed by external equipment.	Limit switch S1 in elevation data module is faulty. Refer to step 8.

Table 3-24 Az/E1 Data Module HTA-6A6A1, 8A7A1 Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Azimuth data module synchro B3	SLEW control at 25 pct full cw	Connect vom to: *a.* TB11-A and TB11-B *b.* TB11-B and TB11-C	*a.* 85 V ac rms max *b.* 85 V ac rms max	If either indication is abnormal, replace B3; if both indications are abnormal, check for 105 V ac (nom) at TB11-N to TB11-P. If indication is 0, replace B3. (Refer to section XVII.)
2	Elevation data module synchro B3	SLEW control at 25 pct full UP	Connect Vom to: *a.* TB5-A and TB5-B *b.* TB5-B and TB5-C	*a.* 85 V ac rms max *b.* 85 V ac rms max	If either indication is abnormal, replace B3; if both indications are abnormal, check for 105 V ac (nom at TB5-N to TB5-P. If indication is 0, replace B3. (Refer to section XVII.)
3	Azimuth data module synchro B1	SLEW control at 25 pct full CCW	Connect vom to: *a.* TB11-E and TB11-F *b.* TB11-F and TB11-G	*a.* 85 V ac rms max *b.* 85 V ac rms max	If either indication is abnormal, replace B1; if both indications are abnormal, check for 105 V ac (nom) at TB11-N to TB11-P. If indication is 0, replace B1. (Refer to section XVII.)
	Elevation data module synchro B1	SLEW control at 25 pct full ON	Connect vom to: *a.* TB5-E and TB5-F *b.* TB5-F and TB5-G	*a.* 85 V ac rms max *b.* 85 V ac rms max	If either indication is abnormal, replace B; if both indications are abnormal, check for105 V ac (nom) at TB5-N to TB5-P. If indication is 0, replace B1. (Refer to section XVII.)
	Azimuth data module synchro B2	SLEW control at 25 pct full cw	Connect vom to: *a.* TB11-J and TB11-K *b.* TB5-F and TB11-L	*a.* 85 V ac rms max *b.* 85 V ac rms max	If either indication is abnormal replace B2 if both indications are abnormal, check for 105 V ac (nom) at TB11-N to TB11-P. If indication is 0, replace B2. (Refer to section XVII.)

Table 3-24 Az/El Data Module HTA-6A6A1, 8A7A1 Troubleshooting Procedure—Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
6	Elevation data module synchro B2	SLEW control at 25 pct full UP	Connect vom to: *a.* TB5-J and TB5-K *b.* TB5-K and TB5-L	*a.* 85 V ac rms max *b.* 85 V ac rms max	If either indication is abo replace B2 if both indica are abnormal, check for 1 ac (nom) at TB5-N to TB If indication is 0, replac (Refer to section XVII.)
7	Azimuth data module limit switch S1	Antenna is not in an azimuth limit position.	Connect vom to: *a.* TB12-A and TB12-B *b.* TB12-E and TB12-F *c.* TB10-A and TB10-B	0 V dc	If any indication is +26 V replace S1.
8	Elevation data module switch S1	Antenna is not in an elevation limit position.	Connect vom to: *a.* TB5-T and TB5-U *b.* TB6-A and TB6-E *c.* TB6-E and TB6-F	0 V dc	If no indication is +26 V re place S1.

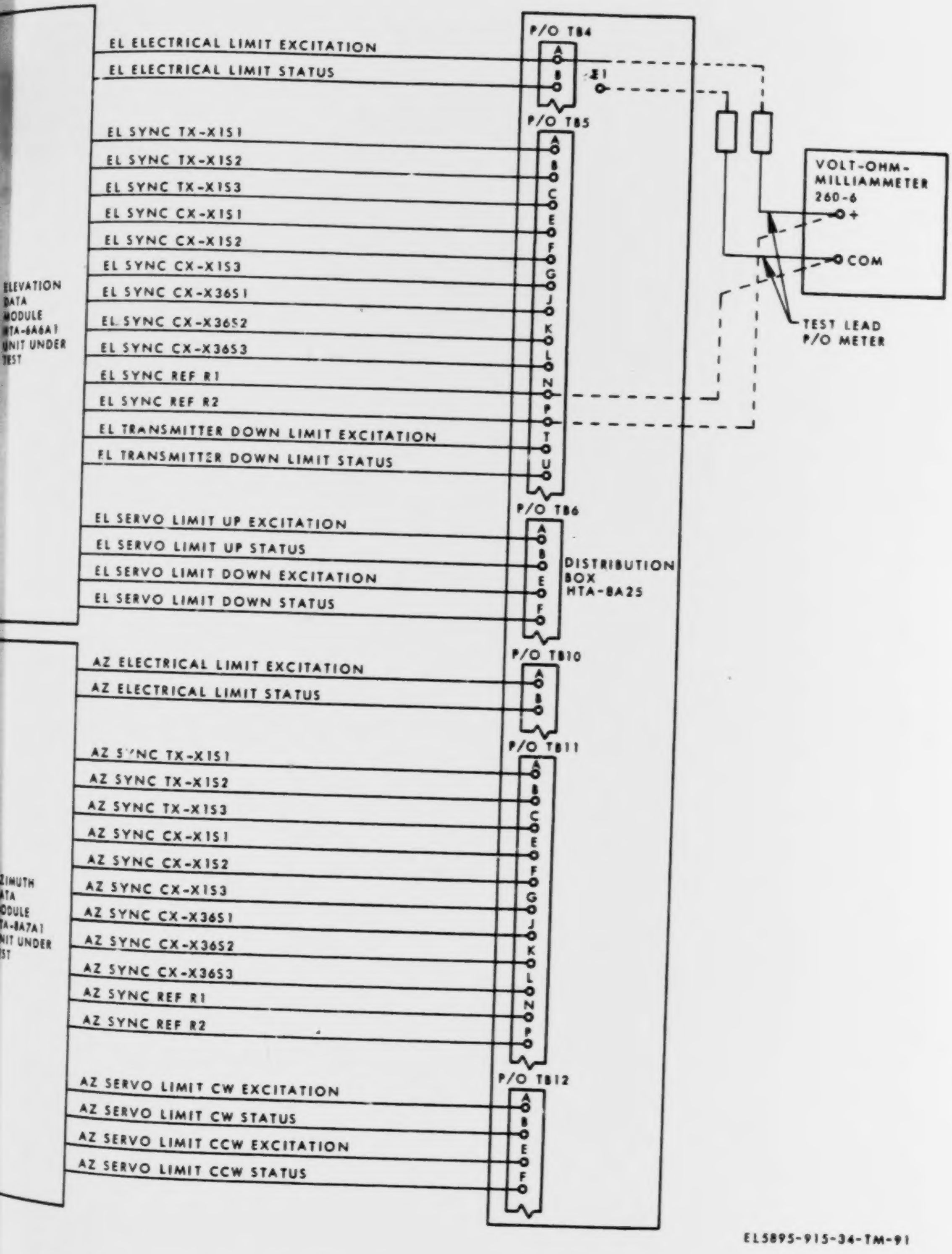

EL ELECTRICAL LIMIT EXCITATION
EL ELECTRICAL LIMIT STATUS
EL SYNC TX-X1S1
EL SYNC TX-X1S2
EL SYNC TX-X1S3
EL SYNC CX-X1S1
EL SYNC CX-X1S2
EL SYNC CX-X1S3
EL SYNC CX-X36S1
EL SYNC CX-X36S2
EL SYNC CX-X36S3
EL SYNC REF R1
EL SYNC REF R2
EL TRANSMITTER DOWN LIMIT EXCITATION
EL TRANSMITTER DOWN LIMIT STATUS
EL SERVO LIMIT UP EXCITATION
EL SERVO LIMIT UP STATUS
EL SERVO LIMIT DOWN EXCITATION
EL SERVO LIMIT DOWN STATUS
ELEVATION DATA MODULE HTA-6A6A1 UNIT UNDER TEST
AZ ELECTRICAL LIMIT EXCITATION
AZ ELECTRICAL LIMIT STATUS
AZ SYNC TX-X1S1
AZ SYNC TX-X1S2
AZ SYNC TX-X1S3
AZ SYNC CX-X1S1
AZ SYNC CX-X1S2
AZ SYNC CX-X1S3
AZ SYNC CX-X36S1
AZ SYNC CX-X36S2
AZ SYNC CX-X36S3
AZ SYNC REF R1
AZ SYNC REF R2
AZ SERVO LIMIT CW EXCITATION
AZ SERVO LIMIT CW STATUS
AZ SERVO LIMIT CCW EXCITATION
AZ SERVO LIMIT CCW STATUS
ZIMUTH ATA ODULE TA-8A7A1 NIT UNDER ST
P/O TB4
A
B
E1
P/O TB5
A
B
C
E
F
G
J
K
L
N
P
T
U
P/O TB6
A
B
E
F
DISTRIBUTION BOX HTA-8A25
P/O TB10
A
B
P/O TB11
A
B
C
E
F
G
J
K
L
N
P
P/O TB12
A
B
E
F
VOLT-OHM-MILLIAMMETER 260-6
+
COM
TEST LEAD P/O METER
EL5895-915-34-TM-91

Figure 3-31. *Az/el data module HTA-6A6A1, 8A7A1, troubleshooting, test setup diagram.*

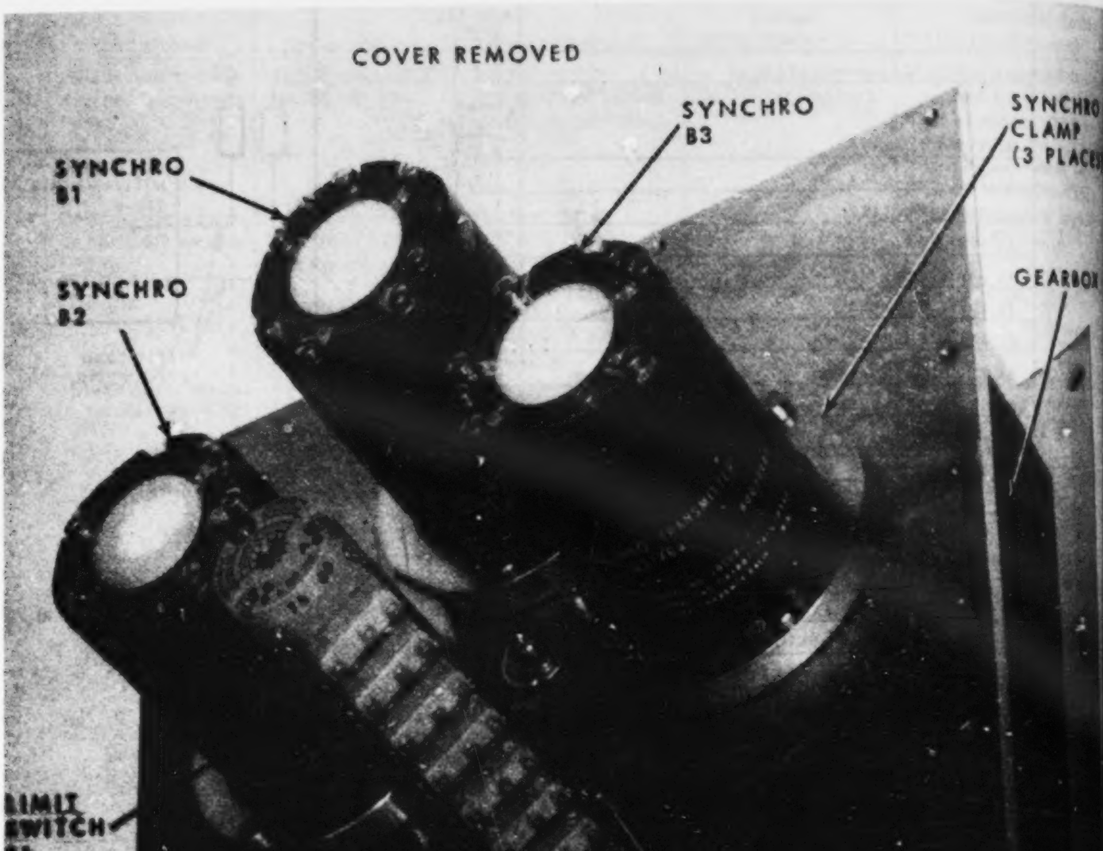

COVER REMOVED
SYNCHRO B1
SYNCHRO B3
SYNCHRO CLAMP (3 PLACES)
SYNCHRO B2
GEARBOX
LIMIT SWITCH S1
RIM CLENCHING CLAMP (3 PLACES)
CLAMP

Figure 3-32. Az/el data module HTA-6A6A1, 8A7A1, parts location (sheet 1 of 2).

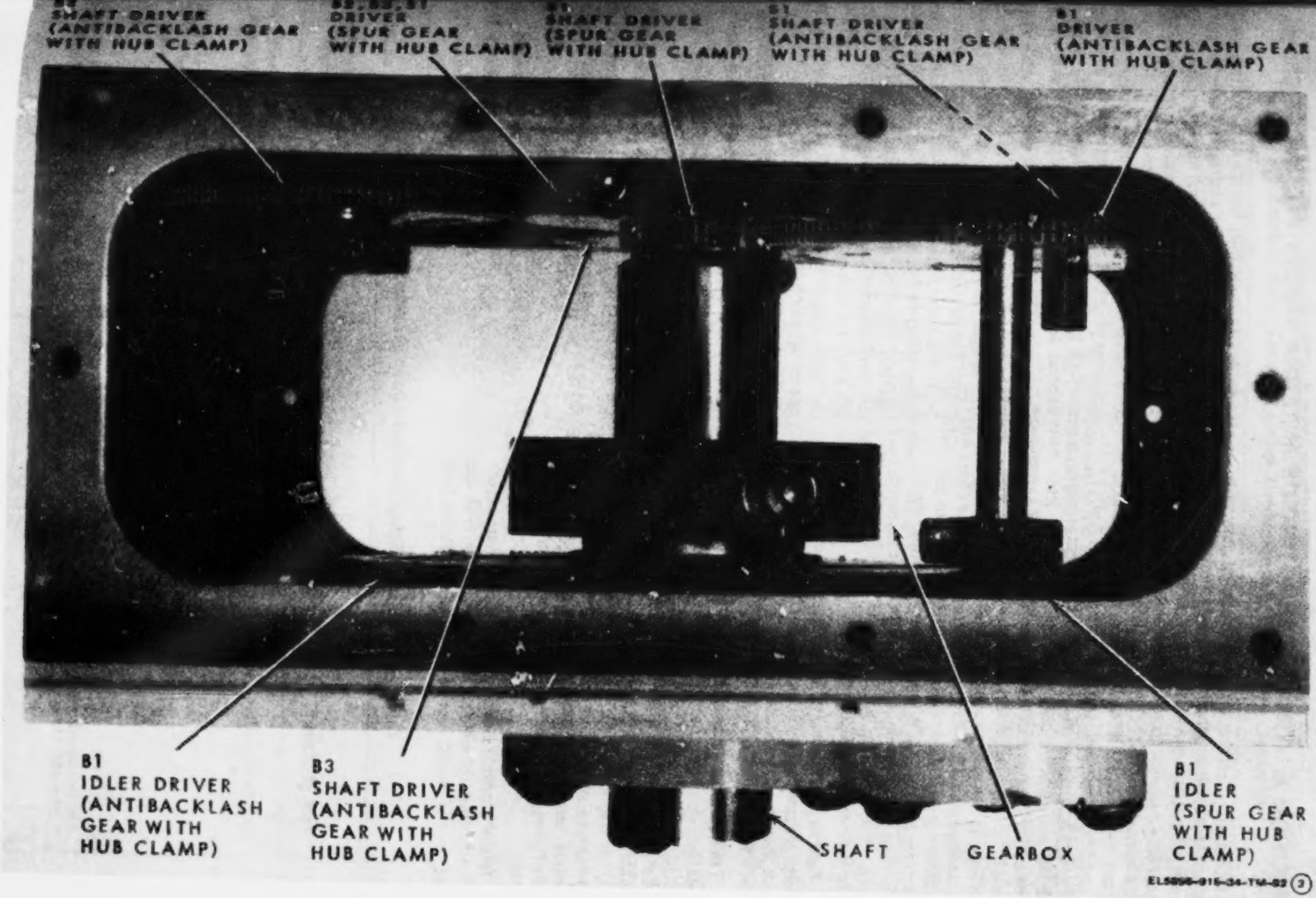

SHAFT DRIVER
(ANTIBACKLASH GEAR
WITH HUB CLAMP)
B2,B3,S1
DRIVER
(SPUR GEAR
WITH HUB CLAMP)
S1
SHAFT DRIVER
(SPUR GEAR
WITH HUB CLAMP)
S1
SHAFT DRIVER
(ANTIBACKLASH GEAR
WITH HUB CLAMP)
B1
DRIVER
(ANTIBACKLASH GEAR
WITH HUB CLAMP)
B1
IDLER DRIVER
(ANTIBACKLASH
GEAR WITH
HUB CLAMP)
B3
SHAFT DRIVER
(ANTIBACKLASH
GEAR WITH
HUB CLAMP)
SHAFT
GEARBOX
B1
IDLER
(SPUR GEAR
WITH HUB
CLAMP)
EL5895-915-34-TM-82 ③

Figure 3-32. Az/el data module HTA-6A6A1, 8A7A1, parts location (sheet 2 of 2).

SECTION X. TROUBLESHOOTING OF ANTENNA SAFETY INTERLOCK GROUP

3-49. General. This section contains preliminary procedures and troubleshooting procedures for fault localization to a malfunctioning assembly or subassembly of the antenna safety interlock group after referral by organizational maintenance or by the servo and control equipment group test (section II). The antenna safety interlock group consists of four antenna safe switches HTA-4A7, 6A9, 8A10, 8A27, breakaway electrical connector plug HTA-P201, and reflector door switch HTA-2A1S1. Preliminary procedures consist of obtaining the listed test equipment, making the prescribed test connections, and initially setting equipment controls to specified settings. These settings, and all subsequent settings given in the troubleshooting procedure, must be made carefully to ensure accurate test results. When a troubleshooting procedure specifies repair or replacement of a malfunctioning assembly, refer to section XVIII in this chapter for the repair or replacement procedure.

3-50. Test Equipment and Materials. The only test equipment required for troubleshooting the antenna safety interlock group is vom 260-6. Test leads are supplied with the vom.

3-51. Test Connections and Conditions (fig. 3-33). Troubleshooting of the antenna safety interlock group is performed with the equipment connected in the operational configuration. All wires from each of the switches in the antenna safety interlock group are routed through distribution box HTA-8A25. All voltage and resistance measurements shall be made by connecting the vom to the distribution box terminal board pins (test points) as shown in figure 3-33 and as specified in the troubleshooting table.

3-52. Initial Control Settings. Press the four antenna safe switches to ANT, OPR, and verify that the reflector door is closed. Verify by visual inspection that the cable wrap assembly has not exceeded the mecha limits of the breakaway electrical connector plug example, only if the antenna has exceeded the az and electrical limits would the disconnect servo be p If the connector has been opened, reinstall and alig cable wrap assembly lanyard and breakaway elect connector plug before troubleshooting the antenna sa interlock group. (Refer to section XVIII.) Set the function switch to +DC and the range switch to 5

3-53. Troubleshooting Procedure. After com ing the preliminary procedures, perform the steps in t 3-25 as specified by the symptom/probable cause li below. The antenna safety interlock group schematic 2-10) will assist in performing the troubleshooting pr dures. Refer to figure 3-34 for antenna safe switch location. After the faulty item has been replaced, perf the performance test procedures described in sec XXXV of this chapter. Upon satisfactory completion the performance test, the antenna safety interlock g can be returned to service.

Symptom	Probable cause
ANT SAFE indicator on antenna position and status panel is lit (white).	Reflector door switch HTA-2A1S2 is faulty. Refer to step 1. One or more antenna safe switches HTA4A7,6A9, 8A1 8A27 are faulty. Refer to step 2. Electrical breakaway connector plug HTA-P201 is faulty. Refer to step 3

Table 3-25 Antenna Safety Interlock Group Troubleshooting Procedure

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
1	Reflector door switch HTA-2A1S1	a. Antenna safety interlock switches closed, +26 V dc present at TB9-B.	a. Connect vom (+) lead to TB9-B and (-) lead to TB41-A.	0 V dc	a. If indication is +26 V dc, re place HTA-2A1S1 (section XVIII).
		b. Antenna not in a transmitter down limit position, reflector door closed, 5 V dc present at TB5-T.	b. Connect vom (+) lead to TB41-N and (-) lead to TB41-E.	0 V dc	b. If indication is +5 V dc, repla HTA-2A1S1 (section XVIII
2	Antenna safe switches HTA-4A7, 6A9,	Antenna safety interlock switches closed, +26	a. Connect vom (+) lead to TB9-B and (-) lead	0 V dc	a. If indication is +26 V dc, re place HTA-4A7 (section

Table 3-25 Antenna Safety Interlock Group Troubleshooting Procedure - Continued

Step	Item of check	Test conditions	Test connections	Normal indication	Additional checks and remarks
	8A10, A27	V dc present at TB9-B.	to TB41-G.		XVIII).
			b. Connect vom (+) lead to TB9-B and (-) lead to TB50-N.	0 V dc	b. If indication is +26 V dc replace HTA-6A9 (section XVIII).
			c. Connect vom (+) lead to TB9-B and (-) lead to TB25-J.	0 V dc	c. If indication is +26 V dc, replace HTA-8A10 (section XVIII).
			d. Connect vom (+) lead to TB9-B and (-) lead to TB25-C.	0 V dc	d. If indication is +26 V dc, replace HTA-8A27 (section XVIII).
	Breakaway electrical connector plug HTA-P201	Antenna safety interlock switches closed, +26 V dc present at TB9-B.	Connect vom (+) lead to TB51-1 and (-) lead to TB51-2.	0 V dc	If indication is +26 V dc, replace HTA-P201 (section XVIII).

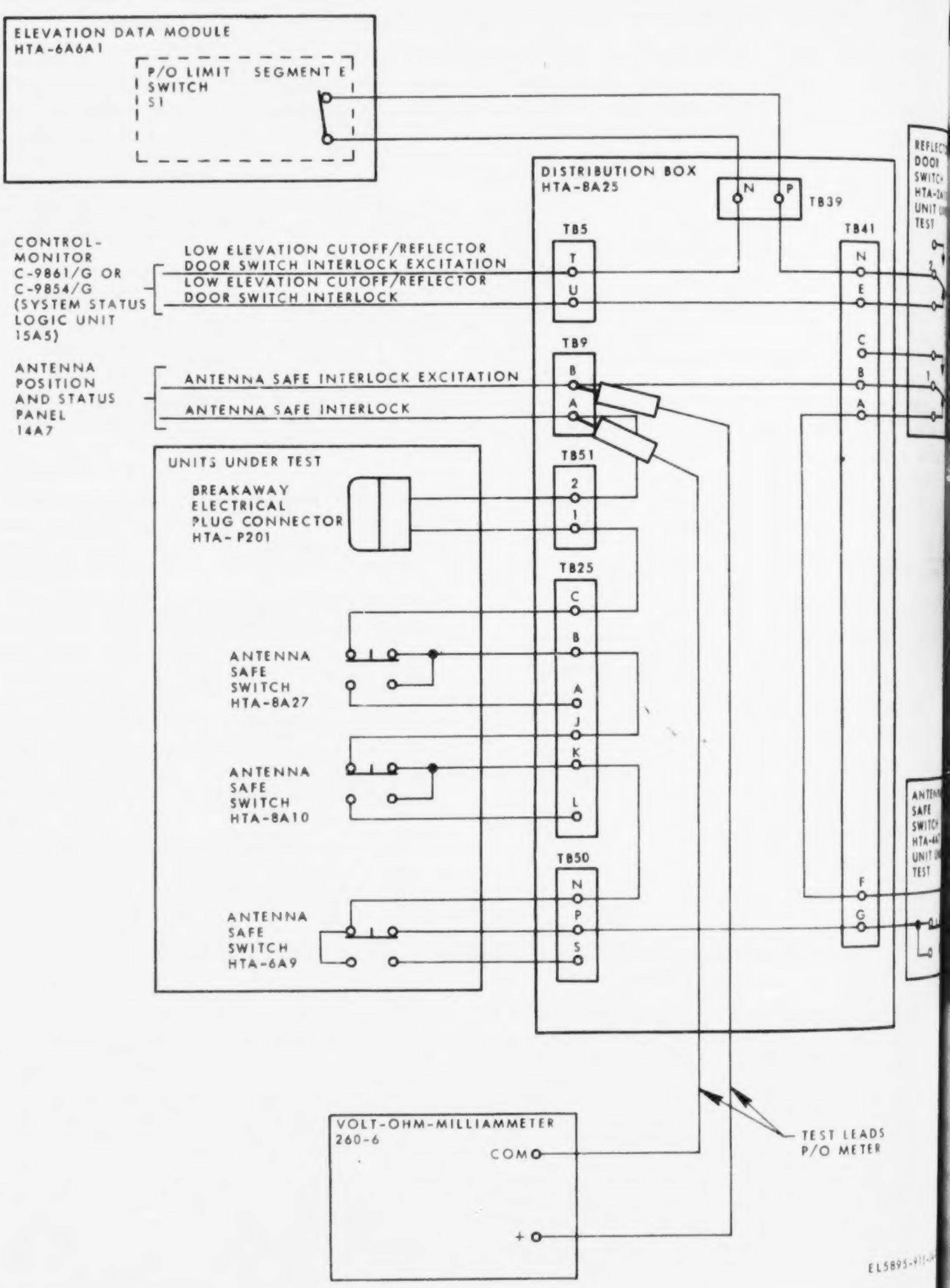

ELEVATION DATA MODULE
HTA-6A6A1
P/O LIMIT SWITCH S1
SEGMENT E
DISTRIBUTION BOX
HTA-8A25
N
P
TB39
TB5
T
U
TB41
N
E
C
B
A
F
G
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
LOW ELEVATION CUTOFF/REFLECTOR DOOR SWITCH INTERLOCK EXCITATION
LOW ELEVATION CUTOFF/REFLECTOR DOOR SWITCH INTERLOCK
ANTENNA POSITION AND STATUS PANEL 14A7
ANTENNA SAFE INTERLOCK EXCITATION
ANTENNA SAFE INTERLOCK
TB9
B
A
UNITS UNDER TEST
BREAKAWAY ELECTRICAL PLUG CONNECTOR HTA-P201
TB51
2
1
TB25
C
B
A
J
K
L
ANTENNA SAFE SWITCH HTA-8A27
ANTENNA SAFE SWITCH HTA-8A10
TB50
N
P
S
ANTENNA SAFE SWITCH HTA-6A9
REFLEC
DOOR
SWITC
HTA-2A
UNIT U
TEST
2
1
ANTEN
SAFE
SWITCH
HTA-4A
UNIT U
TEST
VOLT-OHM-MILLIAMMETER 260-6
COM
+
TEST LEADS P/O METER
EL5895-915-

Figure 3-33. Antenna safety interlock group, troubleshooting, test setup diagram.

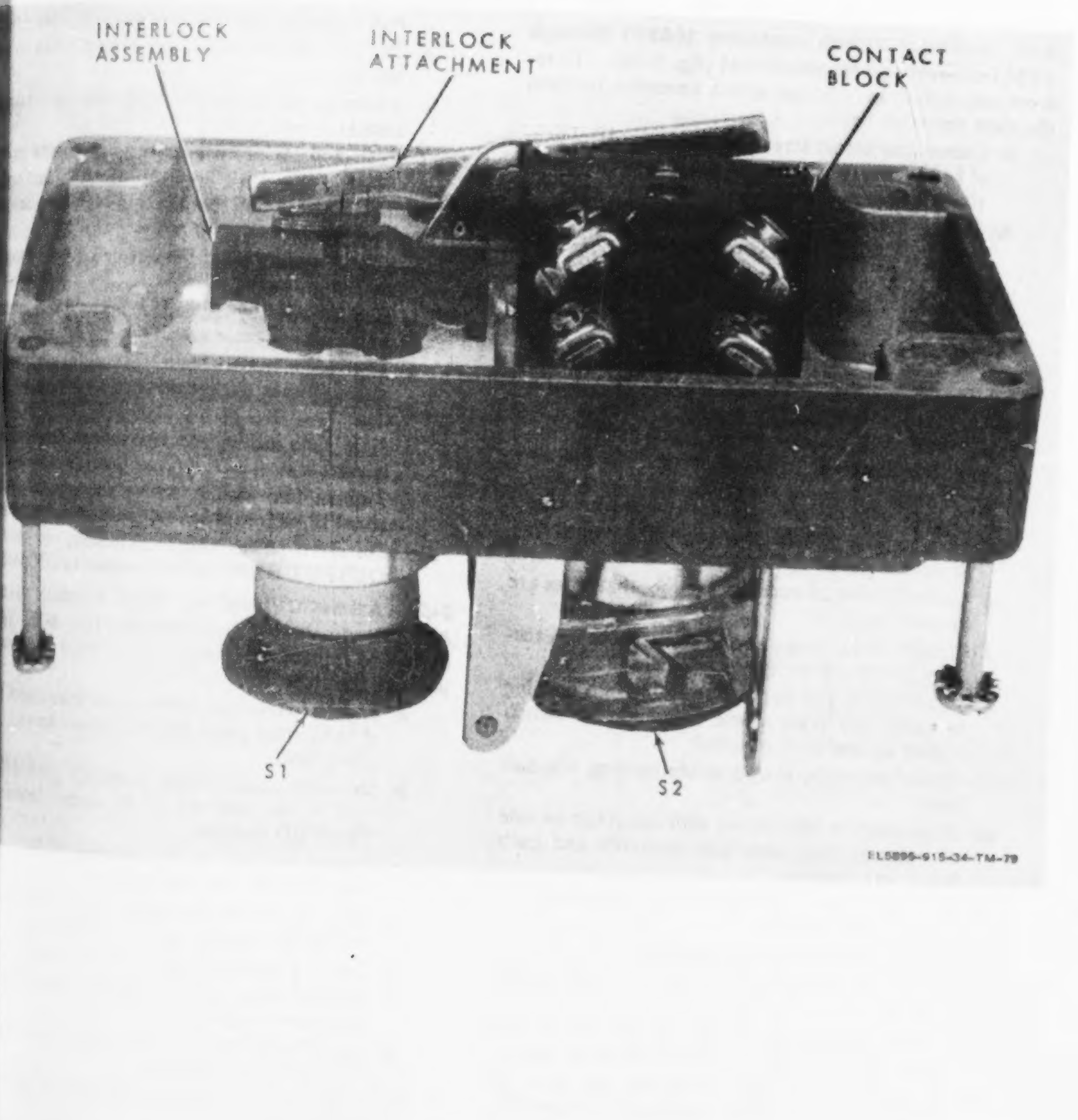

INTERLOCK ASSEMBLY
INTERLOCK ATTACHMENT
CONTACT BLOCK
S1
S2
EL5895-915-34-TM-79

Figure 3-34. Antenna safe switch HTA-4A7, 6A9, 8A10 8A27, parts location.

SECTION XI. MAINTENANCE OF ANTENNA CONTROL PANEL 14A8

3-54. General This section provides instructions for replacing assemblies, subassemblies, or modules of antenna control panel 14A8. Replacement instructions are also provided for panel and chassis-mounted components, such as switches, knobs, and discrete components. Refer to the parts location diagram (fig. 3-3).

3-55. Indicator Switch Assembly 14A8S1 through A8S4 Removal and Replacement (fig. 3-35). To remove and replace an indicator switch assembly, perform the steps described below.

a. Loosen four corner screws on antenna control panel 14A8 front panel and pull chassis outward until slides lock.

b. On servo power supply assembly, set 26 V dc OUTPUT EQPT circuit breaker to TRIPPED position.

c. Pull indicator switch assembly lens assembly forward to stop.

d. Rotate lens assembly one-quarter turn 3 counterclockwise.

e. Push, then pull lens assembly and bulb board from housing.

f. Rotate mounting screws inside housing one-half turn.

g. Tag and unsolder wires from switch and indicator.

h. Push housing from rear through sleeve until free of chassis panel.

i. Clean all wires of solder and ensure that wires are properly stripped.

j. Identify wires by tag and solder wires to replacement switch and indicator.

k. Insert switch and housing assembly into opening in panel and press sleeve from rear of switch tightly against back of panel.

l. Rotate mounting screws inside housing one-half turn.

m. Align notch in bulb board with metal tab on side of housing, then push lens assembly and bulb board into housing.

n. Rotate lens assembly one-quarter turn clockwise to horizontal position.

o. Press lens inward to final position.

p. Press slide locking mechanisms and slide chassis inward.

q. Tighten four corner screws on antenna control panel 14A8 front panel to secure panel to console.

r. On servo power supply assembly, set 26 V dc OUTPUT EQPT circuit breaker to ON position.

3-56. Indicator Assembly 14A8DS1,DS2 Removal and Replacement (fig. 3-3). To remove and replace an indicator assembly, perform the steps described below.

a. Loosen four corner screws on antenna contro el 14A8 front panel and pull chassis outward slides lock.

b. On servo power supply assembly, set 26 OUTPUT EQPT circuit breaker to TRIPPE sition.

c. Pull indicator assembly lens assembly from

d. Tag and remove wires from contact points sembly.

e. Rotate mounting screws inside housing to indicator assembly.

f. Push housing from rear through chassis

g. Insert replacement indicator assembly into ing in panel and push switch assembly in until flush.

h. Rotate mounting screws inside assembly gage front panel.

i. Identify wires by tag and connect wires to co points on indicator assembly.

j. Align notch in bulb board with metal tab ins assembly then push lens assembly into panel tion.

k. Press slide locking mechanisms and slide ch inward.

l. Tighten four corner screws on antenna co panel 14A8 front panel to secure panel to co

m. On servo power supply assembly, set 26 V OUTPUT EQPT circuit breaker to ON pos

3-57. Azimuth/Elevation Slew Control 14A A8R2 Removal and Replacement (fig. 3-3). T move and replace an azimuth or elevation slew co perform the steps described below.

a. Loosen four corner screws on antenna contro el 14A8 front panel and pull chassis outward slides lock.

b. On servo power supply assembly, set +26 V +15 V dc, and -15 V dc circuit breake TRIPPED position.

c. Loosen two set screws securing SLEW co knob to shaft and remove knob.

d. Remove nut and lockwasher that secures slew trol to front panel and remove slew control

e. Tag and unsolder wires to slew control.

f. Identify wires by tags and solder wires to re ment slew control.

g. Install replacement slew control on front with lockwasher and nut.

h. Install knob on slew control shaft and tighte set screws.

i. Press slide locking mechanisms and slide c inward.

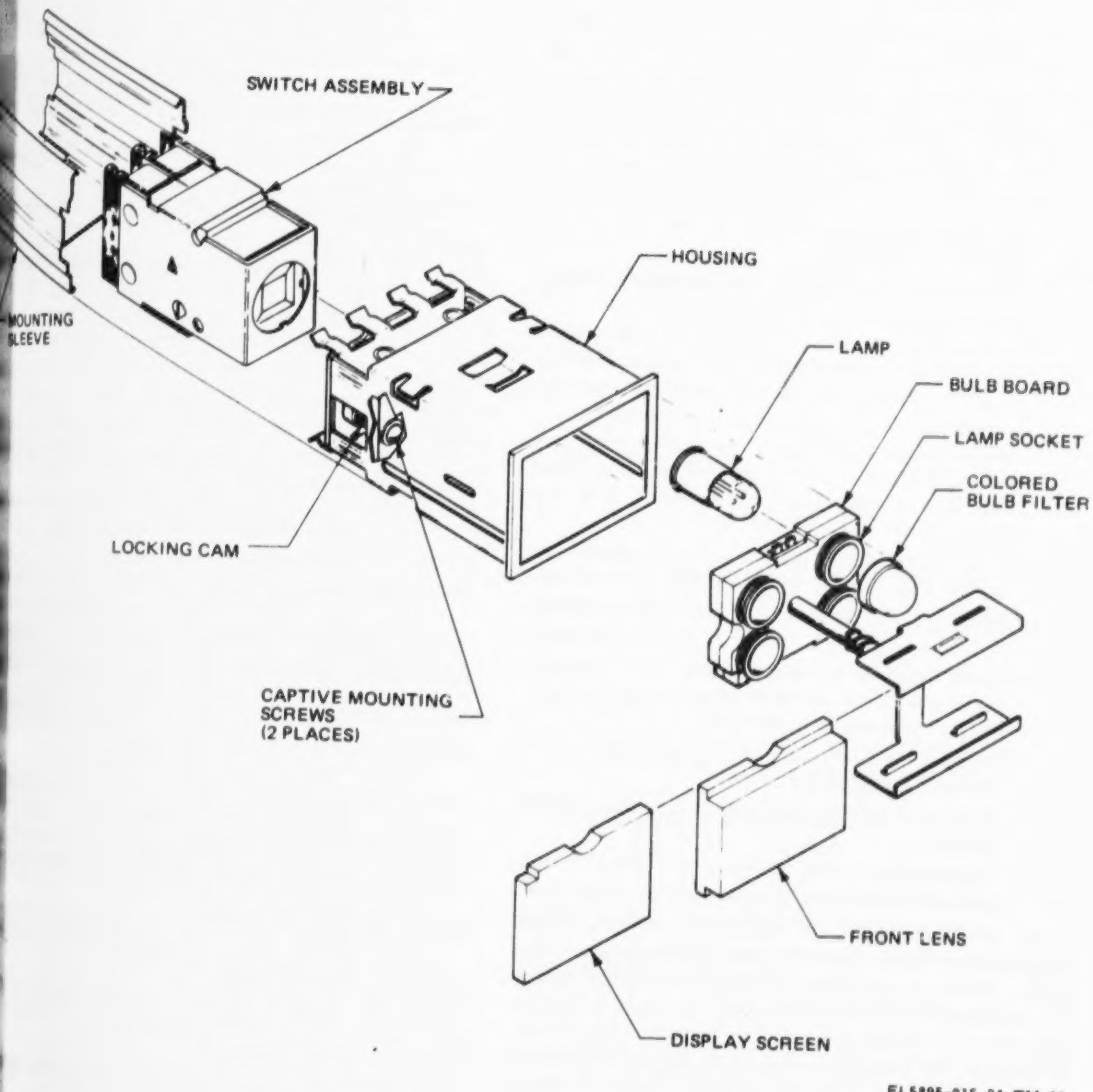

SWITCH ASSEMBLY
MOUNTING
SLEEVE
HOUSING
LAMP
BULB BOARD
LAMP SOCKET
COLORED
BULB FILTER
LOCKING CAM
CAPTIVE MOUNTING
SCREWS
(2 PLACES)
FRONT LENS
DISPLAY SCREEN
EL5895-915-34-TM-93

Figure 3-35. Indicator switch, replacement details

j. Tighten four corner screws on antenna control panel 14A8 front panel to secure panel to console.

k. On servo power supply assembly, set +26 V dc, +15 V dc, and -15 V dc circuit breakers to ON position.

3-58. Instrument Servo Assembly 14A8A1, A8A2 Removal and Replacement (fig. 3-5). To remove and replace an azimuth or elevation instrument servo assembly, perform the steps described below.

a. Loosen four corner screws on antenna control panel 14A8 front panel and pull chassis outward until slides lock.

b. Set all circuit breakers on servo power supply assembly to TRIPPED.

c. Disconnect instrument servo assembly input/output cable.

d. Loosen two setscrews securing handcrank to shaft of instrument servo assembly and slide handcrank, five flat washers, and four spring tension washers from shaft.

e. Remove four phillips-head screws that secure instrument servo assembly to back of front panel and remove instrument servo assembly from antenna control panel 14A8.

f. Install replacement instrument servo assembly on back of front panel with four phillips-head screws.

g. Place five flat washers and four spring tension washers, in alternate order, on handcrank shaft.

h. Install handcrank on shaft and, while pressing handcrank firmly against washer assembly, tighten two setscrews in handcrank.

i. Connect input/output cable to instrument servo assembly receptacle J1.

j. Press slide locking mechanisms and slide chassis inward.

k. Tighten four corner screws on antenna control panel 14A8 front panel to secure panel to console.

3-59. Instrument Servo Assembly 14A8A1, A8A2 Component Parts Removal and Replacement (fig. 3-5). Removal and replacement procedures for motor B1, synchros B2 and B3, and clutch L1 are provided in chapter 4. To remove and replace other components in an azimuth or elevation instrument servo assembly, perform the steps described below, as necessary. Refer to figure 3-5 for parts location and identification.

a. ***Relay K1.*** To remove and replace relay K1, perform the steps described below.

(1) Remove four cover retaining screws and pull chassis from cover (fig. 3-5, sh 1).

(2) Remove four rear plate retaining screws and lockwashers and remove rear plate from support and support posts.

(3) Tag and unsolder leads to relay (fig. 3
3) and to diode CR1 mounted on the
bracket.

(4) Remove three screws and lockwasher
secure relay bracket to chassis. Pull b
out from chassis.

(5) Remove two screws, nuts, and lockw
that secure relay to bracket. Remove

(6) Insert replacement relay in place and
to bracket with two screws, nuts, and
washers.

(7) Insert relay bracket in chassis and secur
three screws and lockwashers.

(8) Identify and solder leads to relay and
terminals.

(9) Install rear plate on support and suppor
(fig. 3-5, sh 1) and secure with four rear
retaining screws and lockwashers.

(10) Install chassis in cover and secure cove
four cover retaining screws.

b. ***Power Supply PS1.*** To remove and replace
supply PS1, perform the steps described below.

(1) Remove four cover retaining screws an
chassis from cover (fig. 3-5, sh 1).

(2) Remove four rear plate retaining scre
lockwashers and remove rear plate fro
port and support posts.

(3) Tag wires and terminals and remove
from top and side of power supply/ser
plifier assembly. (See figure 3-5, she

(4) Tag and remove wires from capacitor C
edge of component board TB1).

(5) Remove two nuts, washers, and lockw
that secure component board to
supply/servo amplifier assembly.

(6) Remove two screws that secure power
servo amplifier assembly to componen

(7) Remove two screws that secure power
servo amplifier assembly to support po
pull assembly from chassis.

(8) Remove two nuts and lockwashers that
power supply to assembly cover and
power supply.

(9) Install replacement power supply in a
cover and secure with two lockwashe
nuts.

(10) Install power supply/servo amplifier
in chassis and secure assembly to
posts with two screws.

(11) Secure assembly to component plate w
screws.

(12) Install component board on power
servo amplifier assembly and secure w
nuts, washers, and lockwashers.

(13) Identify and solder wires to capaci

(14) Identify wires and terminals and solder wires to terminals on top and side of power supply/servo amplifier assembly.

(15) Install rear plate on support and support posts (fig. 3-5, sh 1) and secure with four rear plate retaining screws and lockwashers.

(16) Install chassis in cover and secure cover with four cover retaining screws.

c. ***Servo Amplifier AR1.*** To remove and replace ser- mplifier AR1, perform the steps described below.

(1) Remove four cover retaining screws and pull chassis from cover (fig. 3-5, sh 1).

(2) Remove four rear plate retaining screws and lockwashers and remove rear plate from support and support posts.

(3) Tag wires and terminals and remove wires from top and side of power supply/servo amplifier assembly. (See figure 3-5, sh 5.)

(4) Tag and remove wires from capacitor C1 (at edge of component board TB1).

(5) Remove two nuts, washers, and lockwashers that secure component board to power supply/servo amplifier assembly. Fold back component board as necessary.

(6) Remove two screws that secure power supply/servo amplifier assembly to support posts and pull assembly from chassis.

(7) Remove two nuts and lockwashers that secure power supply to assembly cover and remove power supply.

(8) Remove four nuts and lockwashers that secure servo amplifier to assembly and remove servo amplifier.

(9) Install replacement servo amplifier in assembly cover and secure with four lockwashers and nuts.

(10) Install power supply in assembly cover and secure with two nuts and lockwashers.

(11) Install power supply/servo amplifier assembly in chassis and secure assembly to support posts with two screws.

(12) Secure assembly to component plate with two screws.

(13) Install component board on power supply/servo amplifier assembly and secure with two nuts, washers, and lockwashers.

(14) Identify and solder wires to capacitor C1.

(15) Identify wires and terminals and solder wires to terminals on top and side of power supply/servo amplifier assembly.

(16) Install rear plate on support and support posts (fig. 3-5, sh 1) and secure with four rear plate retaining screws and lockwashers.

(17) Install chassis in cover and secure cover with four cover retaining screws.

d. ***Transformer T1.*** To remove and replace transformer T1, perform the steps described below.

(1) Remove four cover retaining screws and pull chassis from cover (fig. 3-5, sh 1).

(2) Remove four rear plate retaining screws and lock washers and remove rear plate from support and support posts.

(3) Tag and remove wires from transformer terminals. (See figure 3-5, sheet 4.)

(4) Remove two screws and lockwashers and remove transformer from support.

(5) Install replacement transformer on support and secure with two screws and lockwashers.

(6) Identify and connect wires to transformer terminals.

(7) Install rear plate on support and support posts (fig. 3-5, sh 1) and secure with four rear plate retaining screws and lockwashers.

(8) Install chassis in cover and secure cover with four cover retaining screws.

e. ***Transformer T2.*** To remove and replace transformer T2, perform the steps described below.

(1) Remove four cover retaining screws and pull the chassis from the cover (fig. 3-5, sh 1).

(2) Remove four rear plate retaining screws and lockwashers and remove the rear plate from the support and support posts.

(3) Remove four rear plate retaining screws and lockwashers and remove rear plate. (See figure 3-5, sheet 5.)

(4) Tag and remove wires from transformer terminals.

(5) Remove two screws and lockwashers and remove transformer.

(6) Install replacement transformer on support and secure with two screws and lockwashers.

(7) Identify and connect wires to transformer terminals.

(8) Install rear plate on support and support posts (fig. 3-5, sh 1) and secure with four rear plate retaining screws and lockwashers.

(9) Install chassis in cover and secure cover with four cover retaining screws.

f. ***Filter FL1.*** To remove and replace filter FL1, perform the steps described below.

(1) Remove four cover retaining screws and pull chassis from cover (fig. 3-5, sh 1).

(2) Remove four rear plate retaining screws and lockwashers and remove rear plate from support and support posts.

(3) Remove two screws, nuts, and lockwashers and remove filter. (See figure 3-5, sheet 4.)

(4) Tag and remove wires from filter terminals.

(5) Identify and connect wires to filter terminals.

(6) Install replacement filter on rear plate and secure with two screws, nuts, and lockwashers.

(7) Install rear plate on support and support posts (fig. 3-5, sh 1) and secure with four rear plate retaining screws and lockwashers.

(8) Install chassis in cover and secure cover four cover retaining screws.

SECTION XII. MAINTENANCE OF ANTENNA POSITION AND STATUS PANEL 14A7

3-60. General. This section provides instructions for replacing assemblies, subassemblies, or modules of antenna position and status panel 14A7. Replacement instructions are also provided for panel and chassis-mounted components such as switches, knobs, and discrete components. Refer to parts location identification diagram (fig. 3-7).

3-61. Indicator Switch Assembly 14A7S2 Removal and Replacement (fig. 3-7 and 3-35). To remove and replace indicator switch assembly 14A7S2 perform the steps described below.

a. Loosen four corner screws on antenna position and status panel 14A7 front panel and pull chassis outward until slides lock.

b. On servo power supply assembly, set all circuit breakers to TRIPPED.

c. Loosen 18 twistlock fasteners that secure top and bottom covers to chassis and remove covers.

d. Tag and remove wires connected to indicator switch assembly.

e. Pull lens assembly from housing.

f. Rotate mounting screws inside housing to release indicator switch assembly.

g. Push housing from rear through chassis panel.

h. Insert replacement indicator switch assembly into opening in panel and push assembly inward until flush.

i. Rotate mounting screws inside assembly to engage front panel.

j. Identify wires by tag and connect wires to contact points on indicator switch assembly.

k. Align notch in bulb board with metal tab inside of assembly, then push lens assembly into panel position.

l. Press slide locking mechanisms and slide chassis inward.

m. Install chassis covers and secure with 18 twistlock fasteners.

n. Tighten four corner screws on antenna position and status panel 14A7 front panel to secure front panel to console.

o. On servo power supply assembly, set all circuit breakers to ON.

3-62. Indicator Assembly 14A7DS3 thr A7DS13 Removal and Replacement (fig. 3-7 Removal and replacement of indicator asse 14A7DS3 through A7DS13 is the same as antenna trol panel indicator assembly 14A8DS1,14A8DS moval and replacement (see para 3-56), except, to access to the chassis interior, it is necessary to remove chassis top cover after step ***b*** and to replace the top after step ***j***. The cover is secured to the chassis wit twistlock fasteners.

3-63. Azimuth (Elevation) Position Indicator DS1, 14A7DS2 Component Removal and Rep ment (fig. 3-7, sh 2). Removal and replace procedures for an azimuth or elevation position indic a synchro on the position indicators, and the potentio ter on the elevation position indicator are provide subparagraphs ***a***, ***b***, and ***c***, respectively.

a. ***Position Indicator.*** Remove and replace pos indicator as follows:

(1) Loosen four corner screws on antenna pos and status panel 14A7 front panel and chassis outward until slides lock.

(2) On servo power supply assembly, set SY CHRO REF circuit breaker CB TRIPPED position.

(3) Loosen 18 twistlock fasteners and re chassis top cover.

(4) Remove four phillips-head screws, wa and lockwashers securing position indica front panel and partially remove position cator through front of panel to permit a to wire connections.

(5) Tag and disconnect wires to synchro and tentiometer (elevation only) at back of tion indicator and remove position indi

(6) If only the position indicator is to be repl remove the synchro and potentiometer (tion) from the defective position indicato install them in a replacement position in tor as described in subparagraphs *b* and ow.

(7) Install replacement position indicator through front of panel.

(8) Identify wires by tags and connect to sy at back of position indicator, then secure tion indicator with four washers, lockw and screws.

(9) Install chassis cover and secure with 18 twistlock fasteners.

(10) Press slide locking mechanisms and slide chassis inward.

(11) Tighten four corner screws on antenna position and status panel 14A7 front panel to secure panel to console.

(12) On servo power supply assembly, set SYNCHRO REF circuit breaker CB1 to ON position.

Synchro. Remove and replace the synchro on po- indicator as follows.

(1) Remove position indicator from antenna position and status panel 14A7 as described in *a*(1) through *a*(5) above.

(2) Mark position of pointer on indicator.

(3) Loosen three screws that secure clamps to synchro body and turn clamps so that flat sides are toward synchro.

(4) Carefully disengage gears and pull synchro straight out from indicator assembly.

(5) Remove nut and lockwasher securing gear to synchro shaft and remove gear from shaft.

(6) Mark position of gear-limiting nut on shaft and remove nut from synchro shaft.

(7) Install gear-limiting nut on replacement synchro shaft in the same position as on the removed synchro.

(8) Install gear on replacement synchro shaft and secure with lockwasher and nut.

(9) Align pointer as marked in step (2) and, using care when meshing synchro gear with pointer drive gear, insert synchro into position.

(10) Rotate clamps so that flat sides are opposite synchro body and tighten clamp screws finger tight.

(11) Using synchro body, fine align pointer with position indicator on antenna control panel 14A8, then tighten clamp screws.

(12) Replace position indicator in antenna position and status panel 14A7 as described in *a*(7) through *a*(12) above.

Potentiometer. Remove and replace potentiome- elevation position indicator as follows.

(1) Remove elevation position indicator from antenna position and status panel 14A7 as described in *a* (1) through *a* (5) above.

(2) Loosen two clamp screws, rotate clamps so that flat sides are next to potentiometer, and carefully pull potentiometer straight out from position indicator.

(3) Mark relative position of potentiometer shaft to gear and to pointer.

(4) Tag and disconnect wires from potentiometer. Remove gear from potentiometer shaft.

(5) Install gear on replacement potentiometer.

(6) Identify wires by tag and connect wires to replacement potentiometer.

(7) Using care when meshing potentiometer gear with synchro gear, install replacement potentiometer on elevation position indicator backplate.

(8) Rotate clamps so that flat sides are opposite potentiometer and tighten clamp screws.

(9) Replace elevation position indicator on antenna position and status panel 14A7 as described in *a*(7) through *a*(12) above.

3-64. Circuit Card Assembly 14A7A1 through A7A7 Removal and Replacement (fig. 3-7, sh 2). To remove and replace any of seven circuit card assemblies A1 through A7, perform the steps described below.

a. Loosen four screws on antenna position and status panel 14A7 front panel and pull chassis outward until slides lock.

b. On servo power supply assembly, set the PRIMARY POWER and SYNCHRO REF circuit breakers to TRIPPED position.

c. On antenna position and status panel 14A7, loosen 18 twistlock fasteners and remove chassis cover.

d. Loosen six captive screws from card file assembly cover and remove cover.

e. Grasp card extractors with both hands, pry up on frame, and lift circuit card assembly straight out.

f. Carefully insert replacement circuit card assembly in designed space and push in to limits.

g. Install cover on card file assembly with six captive screws.

h. Install chassis cover and secure with 18 twistlock fasteners.

i. Press slide locking mechanisms and slide chassis inward.

j. Tighten four corner screws on antenna position and status panel 14A7 front panel to secure panel to console.

k. On servo power supply assembly, set PRIMARY POWER AND SYNCHRO REF circuit breakers on ON positions.

SECTION XIII. MAINTENANCE OF SERVO POWER SUPPLY ASSEMBLY 14A9

3-65. General. This section provides removal and replacement procedures for assemblies, subassemblies, and modules of servo power supply assembly 14A9 and adjustment procedures for the power supplies and overvoltage protectors. Coarse, front panel voltage adjustment procedures are provided for power supplies PS1 through PS4. Overcurrent and voltage adjustment procedures are provided for power supplies PS2 through PS4. Overvoltage limit adjustment procedures are provided for overvoltage protectors Z1 through Z3. Replacement instructions are also provided for panel and chassis-mounted components such as switches, knobs, and discrete components, and for all components of repairable power supplies PS2 through PS4. Refer power supply PS1 to higher level maintenance for repair. Refer to figure 3-9 for servo power supply assembly parts location diagram.

3-66. Servo Power Supply Assembly 14A9 Power Supplies Coarse Voltage Adjustments. This paragraph provides instructions for adjusting the +26, +15, -15, and +5 V dc power supplies (PS1, PS2, PS3, and PS4, respectively) of servo power supply assembly 14A9, using the front panel MONITOR switch and VOLTAGE meter.

a. Test Equipment and Materials. Only a narrow bladed screwdriver is required to adjust the power supplies.

b. Connections and Conditions. Adjustment of any of the four power supplies is performed with the power supply connected in the normal operating configuration. A hole is provided in the servo power supply assembly 14A9 rear panel to match the +26 V dc pwoer supply adjustment screw. The other power supply adjustment screws are located at the top of the power supplies.

c. Initial Control Settings. On the servo power supply assembly 14A9 front panel, set all PRIMARY POWER CIRCUIT BREAKERS to ON.

d. Adjustment Procedure. Observe VOLTAGE meter on servo power supply assembly 14A9 front panel and rotate MONITOR control to each power supply output monitor position. If meter does not read in green band area for any position, adjust respective power supply adjustment screw to obtain green band (center approximate) reading. When all readings are normal, set MONITOR switch to OFF.

3-67. Circuit Breakers 14A9CB1 through 14A9CB7 Removal and Replacement. To remove and replace any circuit breaker CB1 through CB7, perform the following steps.

- *a.* Set all circuit breakers to TRIPPED position.
- *b.* Loosen four corner screws on servo power supply assembly 14A9 front panel and pull chassis outward until slides lock.
- *c.* On rear of servo power supply assembly 14 disconnect cable 14A1W59 from connector
- *d.* On rear of front panel, tag and unsolder from defective circuit breaker.
- *e.* On front panel, remove hex nut and lockw and remove circuit breaker with lock ring rubber o-ring.
- *f.* Install rubber o-ring and lock ring on replac circuit breaker. Install circuit breaker th rear of front panel and secure with lock w and hex nut.
- *g.* Identify wires by tags and solder to circuit b er.
- *h.* Connect cable 14A1W59 to servo power s assembly 14A9 connector J1.
- *i.* Press slide locking mechanisms and slide c inward.
- *j.* Tighten four corner screws on servo power s assembly 14A9 front panel to secure panel to sole.
- *k.* Set all circuit breakers to ON position.

3-68. +26 V DC Power Supply 14A9PS1 Re and Replacement. To remove and replace +26 power supply PS1, perform the following steps.

- *a.* On front panel, set all circuit breake TRIPPED position.
- *b.* Loosen four corner screws on servo power s assembly 14A9 front panel and pull chassis ward until slides lock.
- *c.* On rear of servo power supply assembly 14 disconnect cable 14A1W59 from connector
- *d.* Tag and disconnect wires from +26 V dc p supply.
- *e.* Remove two screws, flat washers, and lock w ers from power supply retainer and remove r er.
- *f.* Remove four screws securing power s mounting bracket to chassis and lift power s assembly from chassis.
- *g.* Remove six nuts and flat washers from p supply/heat sink mounting bracket. Remove sink and mounting bracket from power s Retain mounting bracket and heat sink for
- *h.* For +26 V dc power supply repair, refer to h level maintenance.
- *i.* Install replacement power supply through side of mounting bracket, so that power s terminals protrude through bracket. Then power supply/heat sink assembly in chassis adjustment hole in chassis rear panel is a with adjustment screw. Secure mounting b with four phillips-head screws.

j. Install power supply retainer in place and secure with two lock washers, flat washers, and machine screws.

k. Identify wires by tags and connect to replacement +26 V dc power supply.

l. Connect cable 14A1W59 to servo power supply assembly 14A9 connector J1.

m. Perform the +26 V dc power supply coarse voltage adjustment procedure (para 3-66).

n. Press slide locking mechanisms and slide chassis inward.

o. Tighten four corner screws on servo power supply assembly 14A9 front panel to secure panel to console.

+15 V DC, -15 V DC, and +5 V DC Power plies 14A9PS2, A9PS3, A9PS4 Removal and Re- ement. To remove and replace a + 15 V dc or -15 power supply (PS2 or PS3), or the +5 V dc power (PS4), perform the steps described below.

a. On front panel of servo power supply assembly 14A9, set all circuit breakers to TRIPPED position.

b. Loosen four corner screws on servo power supply assembly 14A9 front panel and pull chassis outward until slides lock.

c. Disconnect cable 14A1W59 from connector J1.

d. On terminal board of power supply at bottom of chassis, tag and disconnect ac input wires from pins 1, 2, and 5 and dc output/overvoltage protector wires from pins 4 and 6.

e. Loosen two captive screws securing overvoltage protector to power supply and remove overvoltage protector.

f. Remove four screws, flat washers, and lockwashers that secure power supply to power supply mounting bracket at bottom of servo power supply assembly 14A9. Remove power supply from assembly.

Install repaired or replacement power supply on power supply mounting bracket at bottom of servo power supply assembly 14A9 with four phillips-head screws, flat washers, and lockwashers.

Install overvoltage protector on power supply with the two captive screws.

Identify wires by tags and connect to power supply terminal strip. Verify or install jumpers between pins 3 and 4 and between pins 6 and 7 on power supply terminal board.

Connect cable 14A1W59 to servo power supply assembly 14A9 connector J1.

Press slide locking mechanisms and slide chassis inward.

l. Tighten four corner screws on servo power supply assembly 14A9 front panel to secure panel to operator's console.

m. Set all circuit breakers to ON position.

n. Perform coarse voltage adjustment for 15 V dc power supply (para 3-66).

3-70. +15 V DC and -15 V DC Power Supply 14A9PS2, 14A9PS3 Component Removal and Replacement.

a. Power Supply Cover (fig. 3-11, sh 1). For access to the internal power supply parts, the power supply cover must be removed. Remove and replace it as follows:

(1) On front of power supply, remove bottom three phillips-head screws.

(2) Place power supply bottom side up on bench. Remove three phillips-head screws on bottom side and remove cover.

(3) For access to power supply components, carefully slide power supply cover away from chassis until extended to length of cable.

(4) Replace bottom cover on power supply and align with mounting holes on front and bottom of supply. Secure bottom cover to supply with three phillips-head screws on bottom and three on lower front of power supply.

b. Power Transformer T1 (fig. 3-11, sh 2). Remove and replace power transformer T1 as follows:

(1) Remove power supply cover (para 3-70*a*).

(2) Tag destination points of wires connected to power transformer T1 for identification.

(3) Remove power transformer T1 cable tie-wraps.

(4) Remove four corner screws that secure pcb B. Fold pcb B over for access to transformer connections.

(5) Unsolder and disconnect wires connected to power transformer T1.

(6) Remove two phillips-head screws that secure power transformer T1.

(7) Remove power transformer T1.

(8) Install replacement power transformer T1 in power supply chassis so that mounting holes are aligned with mounting holes on chassis.

(9) Insert phillips-head screws in each power transformer T1 mounting hole and secure to chassis.

(10) Solder transformer wires to applicable tagged destination points.

(11) Secure pcb B with four corner screws.

(12) Replace cover on power supply (para 3-70*a*).

(13) Perform test procedures in section XXIV of this chapter.

c. Filter Capacitor C8 (fig. 3-11, sh 2). Remove and replace filter capacitor C8 as follows:

(1) Remove power supply cover (para 3-70a).
(2) Place power supply chassis left side up on bench.
(3) Remove four corner screws that secure PC board B. Fold PC board over for access to capacitor C8.
(4) Identify destination points of wires connected to filter capacitor C8. Unsolder wires.
(5) Remove capacitor C8 from mounting clamp.
(6) Position power supply chassis left side up on bench.
(7) Install replacement filter capacitor C8 in power supply capacitor mounting clamp.
(8) Solder capacitor C8 wires to identified destination points on power supply.
(9) Install cover on power supply (para 3-70a).
(10) Perform test procedures in section XXIV of this chapter.

d. Series Regulator Transistor Q8 (fig. 3-11, sh 5). Remove and replace series regulator transistor Q8 as follows:

(1) Remove power supply cover (para 3-70a).
(2) Replace power supply bottom side up on bench.
(3) On front cover of power supply, remove four hex head bolts that secure transistor Q8 heat sink assembly.
(4) Remove cable tie-wrap screw (fig. 3-11, sh 6).
(5) Remove transistor Q8 and heat sink assembly from cover.
(6) Tag for identifiction and unsolder two wires on bottom side of transistor Q8.
(7) Remove hex nut from back of the two mounting screws that secure transistor Q8 to the heat sink assembly.
(8) Remove transistor Q8 from mounting screws. Remove and inspect insulating wafer. Replace if cracked.
(9) Coat both sides of insulating wafer with heat sink compound (Dow Corning no. 340 silicone grease, or equivalent).
(10) Install insulating wafer and replacement transistor Q8 or heat sink mounting screws.
(11) Install hexnut on each mounting screw to secure transistor Q8 to heat sink assembly.
(12) Solder tagged wires to applicable pins on bottom side of transistor Q8.
(13) Install heat sink assembly with transistor Q3 on interior side of front cover so that heat sink mounting holes are aligned with mounting holes on front cover.
(14) Secure heat sink assembly to front cover with four hex head mounting bolts.
(15) Secure cable tie-wrap scre to cover.
(16) Install cover on power supply (para 3-70a).
(17) Perform test procedures in section XX
this chapter.

e. Printed Circuit Board Components Remo
Replace- ment. When a defective component
printed circuit board is to be replaced, observe the
tenance techniques described below.

(1) When unsoldering a component, never
force it loose; unsolder component by
wicking process described below:
  (a) Select 3/16-inch tinned copper
  use as wick; if braid is not available
  AWG no. 16 stranded wire with 1/
  insulation removed.
  (b) Dip wick in liquid rosin flux.
  (c) Place wick on soldered connectio
  apply soldering iron to wick.
  (d) When sufficient amount of solder
  onto wick, freeing component,
  ously remove iron and wick.
(2) When soldering semiconductor devices
the lead being soldered with a pair of
place a commercial heat sink device
the component and the solder joint.
(3) Always use a heat sink when soldering
tors; a transistor pad with mounting
effective heat sink.
(4) If foil is intact, but not covered with
is a good contact. Do not attempt to cover
solder.
(5) Broken or damaged printed wiring is
the result of an imperfection, strain,
less soldering. To repair small break
short piece of hook-up wire to bridg
break, and holding the wire in place,
der along the length of wire so that it
part of the circuitry.
(6) Check and clean all replacement
leads prior to soldering, regardless of
appearance.
(7) Use smooth finished tools for bending
avoid use of any sharp-edged tool th
pinch or break the lead. Leave a dis
at least twice the diameter of the
the end seal of the component to the
the bend. This rule also applies to all
nents with soldered leads, such as
capacitors.
(8) Position the replacement compone
same place as the removed compone
mount component on top of another
nent. Position the replacement comp
that any identification mark, such as
number, symbol, value, etc., is readily
(9) Observe the polarity of replacemen
transistors, and electrolytic and
pacitors.

(10) Perform test procedures in section XXIV.

3-71. +5 V DC Power Supply 14A9PS4 Component t Removal and Replacement (fig. 3-12). Removal and lacement procedures for components in +5 V dc power ply 14A9PS4 are the same as the procedures for +15 V and -15 V dc power supplies 14A9PS2 and 14A9PS3. fer to paragraph 3-70 for these procedures.

72. +15 V DC and -15 V DC Power Supply 14A9PS2, A9PS3 Overcurrent Control R17 Adjustment. Adjustment of overcurrent control R17 on printed circuit board B is required when transistor Q3, resistor R14, or overcurrent potentiometer R17 is replaced and voltage and current indications do not reflect maximum ratings.

a. Test Equipment and Materials. Table 3-26 lists the test equipment and materials required for the adjustment of overcurrent control R17.

Table 3-26 Test Equipment Required for 15 V DC, -15 V DC, and 5 V DC Power Supplies 14A9PS2, A9PS3, A9PS4 Overcurrent Adjustment and Performance Test Procedures

Common name	Part/model no.	Qty	Manufacturer
ne Cord	17449-S	1	Belden
er, AC, 3-Wire to 2-Wire	785-0419	1	Allied
er, Banana Jack to Spade Lug	3744	7	Pomona
er, Binding Post to Banana Plug	2894	2	Pomona
ter, DC, Multirange	749-2091001	1	Weston Instruments
, Multifunction	3450B	1	Hewlett-Packard
meter, Volt-Ohm- (VOM)	260-6	1	Simpson
cope, Dual-Trace	475	1	Tektronix
t, Carbon Compression	82905	1	Central Scientific
ad, Banana Plug to Alligator Clip	1166-36-B	1	Pomona
d, Banana Plug to Banana Plug	B-48 (B)	3	Pomona
d, Banana Plug to Banana Plug	B-48 (R)	2	Pomona
d, BNC Plug to Double Banana (44")	11001A	1	Hewlett-Packard
d, Spade Lug to Banana Plug	1370-24-B	1	Pomona
d, Spade Lug to Banana Plug	1370-24-R	1	Pomona
d, Spade Lug to Spade Lug	1743-36-R	1	Pomona
er, Variable	3PN2210	1	Staco

Test Connections and Conditions. Adjustment of rrent control is accomplished in a bench test Prior to performing the adjustment, prepare the nt as follows:

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable trans-

former for 115 V ac indicator on vom. Set variable transformer power switch to OFF. Disconnect vom.

(3) Remove power supply cover (para 3-70**a**).
(4) Locate potentiometer R17 on printed circuit board B (fig. 3-11, sh 3). The adjustable (inner) section of R17 is solder-sealed to the outer casing. This seal prevents inadvertent movement of the wiper following factory adjustment. Unsolder the seal and adjust R17 to the full cw position.
(5) Connect equipment as shown in figure 3-36.
(6) Adjust rheostat for maximum resistance (fully ccw).

c. Initial Test Equipment Settings. Initial test equipment settings for the adjustment procedure as as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Dual-channel oscilloscope	
POWER	On (pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe signal
CH1 AC-GND-DC	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER - SLOPE and LEVEL	As required for stable display
Variable transformer	
Power switch	ON

d. Adjustment Procedure. Perform the adjustment as follows:

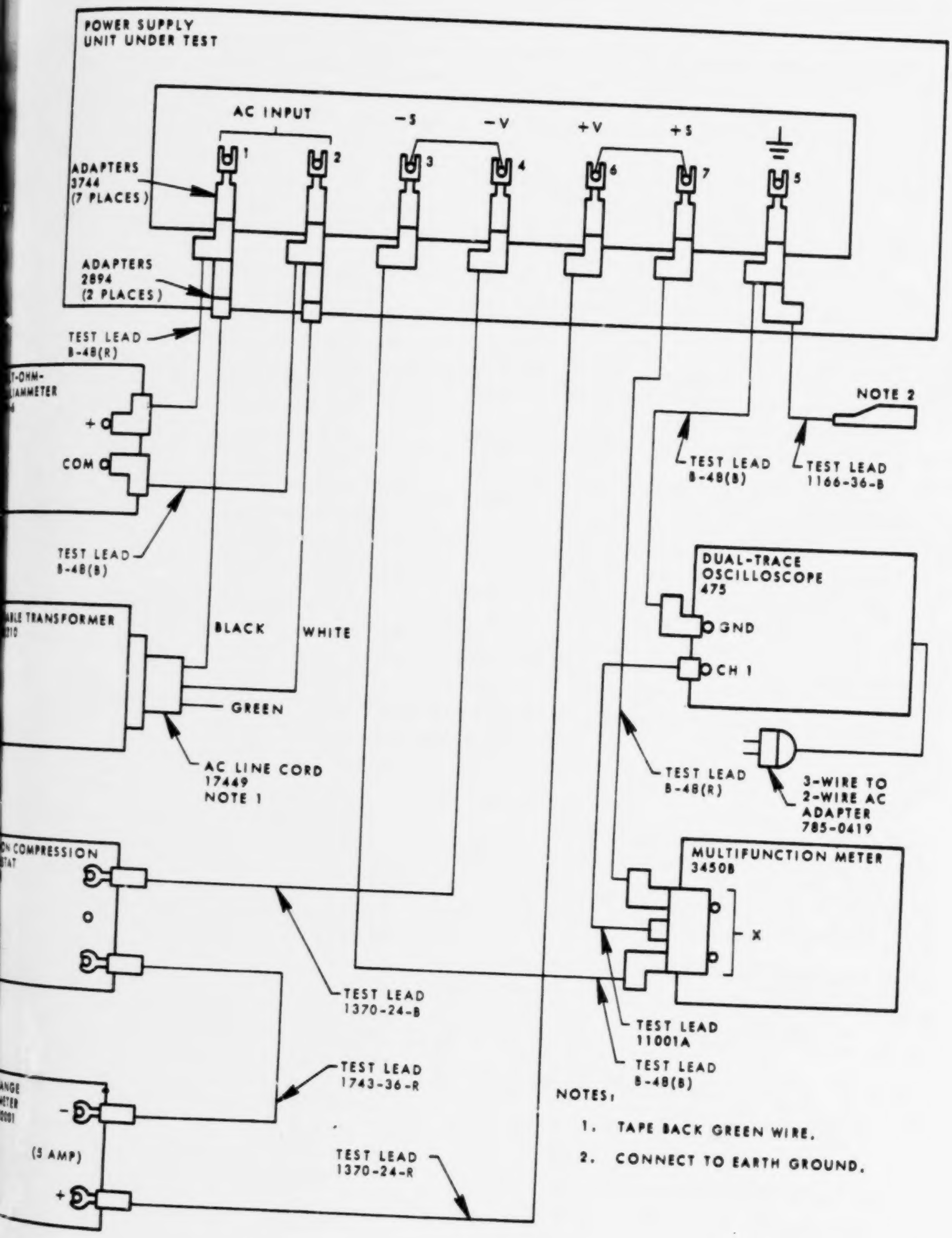
(1) Disconnect load from power supply by disconnecting test lead from negative terminal of dc ammeter.
(2) On front side of power supply (fig. 3-11, sh 1) adjust V DC control for an indication of 14.25 V dc on multifunction meter.
(3) Reconnect test lead to negative termina ammeter as shown in figure 3-36.
(4) Adjust rheostat for 3.85 amperes (110 p of 40 degree C rating for unit) indicati dc ammeter.
(5) Observe oscilloscope and adjust R17 (f 11, sh 3) on circuit card in a ccw di until output ripple increases sharply and loscope pattern changes.
(6) On variable transformer, place power to OFF.
(7) On power supply printed circuit board der seal the adjustable (inner) section o to the outer casing, to prevent further ment of the wiper, and increase resista rheostat (rotate ccw).
(8) After soldering, check setting of R17 b ting variable transformer power swi ON. Adjust rheostat to produce a load c of 3.85 amperes while observing the o scope and current meter. When load c indication on current meter reaches 3.8 peres, verify that output ripple inc sharply and oscilloscope pattern chan indications on oscilloscope are not as fied, set variable transformer power swi OFF, unsolder solder seal of R17, set va transformer to ON and repeat ste through (8).
(9) Adjust rheostat to reduce load current ampere.
(10) On front of power supply, adjust VDC c for indication of 15 ±0.15 V dc on mul tion meter.
(11) On variable transformer, set power sw OFF.
(12) Disconnect test equipment and replac on power supply (para 3-70**a**).
(13) Perform test procedures in section XI this chapter.

3-73. +5 V DC Power Supply 14A9PS4 Overc Adjustment. Overcurrent adjustment is requir transistor Q3, resistor R14, or overcurrent poten R17 is replaced and voltage and current indica not reflect maximum ratings.

a. Test Equipment and Materials. The te ment and materials required to adjust +5 V d supply 14A9PS4 overcurrent control R17 is listed 3-26.

b. Test Connections and Conditions. Test tions and conditions for this adjustment are the for +15 V dc and -15 V dc power supplies 14A9P 14A9PS3. Prior to performing the adjustment, the equipment as indicated in paragraphs 3-72b

c. Initial Test Equipment Settings. Initial te ment settings for this adjustment are as indicated graph 3-72c.


POWER SUPPLY
UNIT UNDER TEST
AC INPUT
1
2
−S
3
−V
4
+V
6
+S
7
5
ADAPTERS
3744
(7 PLACES)
ADAPTERS
2894
(2 PLACES)
TEST LEAD
B-48(R)
T-OHM-
IAMMETER
+
COM
TEST LEAD
B-48(B)
BLE TRANSFORMER
210
BLACK
WHITE
GREEN
AC LINE CORD
17449
NOTE 1
N COMPRESSION
TAT
TEST LEAD
1370-24-B
ANGE
ETER
0001
−
(5 AMP)
+
TEST LEAD
1743-36-R
TEST LEAD
1370-24-R
NOTE 2
TEST LEAD
B-48(B)
TEST LEAD
1166-36-B
DUAL-TRACE
OSCILLOSCOPE
475
GND
CH 1
TEST LEAD
B-48(R)
3-WIRE TO
2-WIRE AC
ADAPTER
785-0419
MULTIFUNCTION METER
3450B
X
TEST LEAD
11001A
TEST LEAD
B-48(B)

NOTES:

1. TAPE BACK GREEN WIRE.
2. CONNECT TO EARTH GROUND.

FL5895-915-34-TM-94

Power supplies 14A9PS2, A9PS3, A9PS4, overcurrent adjustment and performance test, test setup diagram.

d. Adjustment Procedure. Perform the adjustment as follows:

(1) Disconnect load from power supply by disconnecting test lead from negative terminal of dc ammeter.

(2) On front side of power supply (fig. 3-12, sh 1) adjust VDC control for an indication of 4.75 V dc on multifunction meter.

(3) Reconnect test lead to negative terminal of dc ammeter as shown in figure 3-36.

(4) Adjust rheostat for 4.1 amperes (110 percent of 40 C rating for unit) indication on dc ammeter.

(5) Observe oscilloscope and adjust R17 (fig. 3-12, sh 3) on circuit card in a ccw direction until output ripple increases sharply and oscilloscope pattern changes.

(6) On variable transformer, set power switch to OFF.

(7) On power supply printed circuit board B, solder seal the adjustable (inner) section of R17 to the outer casing, to prevent further movement of the wiper, and increase resistance of rheostat (rotate ccw).

(8) After soldering, check setting of R17 by setting variable transformer power switch to ON. Adjust rheostat to produce load current of 4.1 amperes while observing oscilloscope and current meter. When load current tion on current meter reaches 4.1 an verify that output ripple increases sharp oscilloscope pattern changes. If indicati oscilloscope are not as specified, set va transformer power switch to OFF, un wiper of R17, set variable transformer and repeat steps (1) through (8).

(9) Adjust rheostat to reduce load current amperes.

(10) On front of power supply, adjust VDC c for indication of 5 ±0.05 V dc on mult tion meter.

(11) On variable transformer, set power swi OFF.

(12) Disconnect test equipment and replace on power supply (para 3-70a).

(13) Perform test procedures in section XX this chapter.

3-74. Power Supplies 14A9PS2, A9PS3, A Voltage Adjustments. This paragraph provides liminary procedures and voltage adjustment proce for +15, -15, or +5 V dc power supplies 14A through PS4.

a. Test Equipment and Materials. Table 3-27 the test equipment and materials required for p supply output voltage adjustment.

Table 3-27 Test Equipment Required for Power Supply 14A9PS2, A9PS3, A9PS4 Output Voltage Adjustment

Common name	Part/model no.	Qty	Manufactur
AC Line Cord	17449-S	1	Belden
Adapter, Banana Jack to Spade Lug	3744	3	Pomona
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Meter, Multifunction	3450B	1	Hewlett-Packard
Milliammeter, Volt-Ohm- (VOM)	260-6	1	Simpson
Test Lead, Banana Plug to Banana Plug	B-48(B)	1	Pomona
Test Lead, Banana Plug to Banana Plug	B-48-(R)	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
Transformer, Variable	3PN2210	1	Staco

b. ***Test Connections and Conditions.*** Prior to performing the adjustment, prepare the equipment as follows:

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

(3) Connect equipment as shown in figure 3-10, except dual-trace oscilloscope is not required.

(4) Connect multifunction meter positive (red) test lead to TB1 terminal 6 and negative (black) test lead to TB1 terminal 4 on power supply being adjusted.

c. ***Initial Test Equipment Settings.*** Initial test equipment settings for the adjustment procedure as as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Variable transformer	
Power switch	ON

d. ***Adjustment Procedure.*** Using VDC control, on front side of the power supply adjust output voltage for a multifunction meter indication as follows: PS2 and PS3, 15 ±0.15 V dc; PS4, 5 ±0.05 V dc.

Overvoltage Protectors 14A9Z1 through Z3 Removal and Replacement. To remove and ce any servo power supply assembly 14A9 overvoltatector Z1 through Z3, perform the following steps.

On front panel of servo power supply assembly 14A9, set all circuit breakers to TRIPPED position.

Loosen four corner screws on servo power supply assembly 14A9 front panel and pull chassis outward until slides lock.

Disconnect cable 14A1W59 from connector J1.

On terminal board at rear of power supply, tag and disconnect overvoltage protector wires from pins 4 and 6.

e. Loosen two captive screws securing overvoltage protector to power supply and remove overvoltage protector.

f. Install replacement overvoltage protector on power supply with the two captive screws.

g. Perform adjustment procedure for replaced overvoltage protector (para 3-76).

h. Identify wires by tags and connect to power supply terminal board.

i. Connect cable 14A1W59 to servo power supply assembly 14A9 connector J1.

j. Press slide locking mechanisms and slide chassis inward.

k. Tighten four corner screws on servo power supply assembly 14A9 front panel to secure panel to operator's console.

3-76. Overvoltage Protectors 14A9Z1, A9Z2, A9Z3 Adjustment. This paragraph describes the test equipment, connections and conditions, initial control settings, and procedures for adjustment of overvoltage protectors 14A9Z1, A9Z2, and A9Z3.

a. ***Test Equipment and Materials.*** The following test equipment is required for the adjustment.

(1) Multifunction meter, Hewlett-Packard 3450B

(2) Test leads, Pomona 1166-36-B and 1166-36-R (banana plug to alligator clip).

b. ***Connections and Conditions.*** The overvoltage protector is adjusted while mounted on the power supply in servo power supply assembly 14A9 and connected in a normal, no-load configuration. Prepare equipment for adjustment as follows.

(1) On front panel of servo power supply assembly, set applicable PRIMARY POWER circuit breaker to TRIPPED.

(2) Loosen four corner screws on servo power supply assembly front panel and pull chassis outward until slides lock.

(3) Tag and disconnect output leads connected to power supply terminal board terminals 3, 4, 6, and 7. Do not disconnect wires connected to overvoltage protector or jumpers between terminals 3 and 4 and terminals 6 and 7.

c. ***Initial Control Settings.*** Set controls as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL

Control	Position
TRIGGER	INT
Overvoltage protector	
ADJUST	Full cw (approximately 20 turns)

d. Overvoltage Protector Z1 and Z2 Adjustment Procedure. Perform overvoltage protector Z1 or Z2 adjustment as follows:

(1) Connect negative (black) test lead from black X terminal on multifunction meter to terminal 3 and positive (red) test lead from red X terminal to terminal 7 on power supply terminal board.

(2) On servo power supply assembly, set applicable +15 VDC or -15 VDC power supply circuit breaker to ON.

(3) On front of power supply, adjust VDC control for an indication of +18.25 V dc on multifunction meter.

(4) While observing multifunction meter, slowly turn overvoltage protector ADJUST control counterclockwise until power supply output voltage drops. Overvoltage protection point is now set.

(5) Rotate power supply VDC control fully counterclockwise.

(6) Set power supply circuit breaker to TRIPPED.

(7) Identify and connect output leads to terminals 3, 4, 6, and 7 on power supply terminal board.

(8) Set power supply circuit breaker to ON.

(9) Using power supply VDC control, adjust power supply voltage to +15 ±0.15 V dc, as indicated on multifunction meter.

(10) Set power supply circuit breaker to TRIPPED.

(11) Disconnect test equipment from unit under test.

(12) Press tow slide locking mechanisms and chassis inward.

(13) Tighten four corner screws on servo supply assembly front panel to secure console.

e. Overvoltage Protector Z3 Adjustment Proc Perform overvoltage protector Z3 adjustment as

(1) Connect negative (black) test lead from X terminal on multifunction meter to nal 3 and positive (red) test lead from red terminal to terminal 7 on power supply nal board.

(2) On servo power supply assembly, set +5 power supply circuit breaker to ON.

(3) On front of +5 V dc power supply 14A adjust VDC control for an indication of ±0.2 V dc on multifunction meter.

(4) While observing multifunction meter, turn overvoltage protector ADJUST counterclockwise until power supply voltage drops. Output voltage protector is now set.

(5) Rotate power supply VDC control fully terclockwise.

(6) Set power supply circuit breaker TRIPPED.

(7) Identify and connect output leads to 3, 4, 6, and 7 on power supply terminal

(8) Set power supply circuit breaker to ON

(9) Using power supply VDC control, adjust er supply voltage to +5 ±0.05 V dc, as cated on multifunction meter.

(10) Set power supply circuit breaker to TRI

(11) Disconnect test equipment from unit test.

(12) Press slide locking mechanisms and chassis inward.

(13) Tighten four corner screws on servo supply assembly front panel to secure console.

SECTION XIV. MAINTENANCE OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24

3-77. General. This section provides instructions for replacing assemblies, subassemblies, or modules of stow pin control/minor fault summary panel HTA-8A24. Replacement instructions are also provided for panel and chassis-mounted components such as switches, knobs, and connectors. Adjustment procedures are provided for the +26 V dc power supply. For parts location and identification, see figure 3-14. When performing maintenance inside the stow pin control/minor fault summary HTA-8A24 chassis, turn off ac power at CB7 in tion box HTA-8A25. At completion of mainten set CB7.

WARNING

120 V ac is present on circuit breaker CB1 contacts inside the stow pin control/minor fault summary panel chassis. Do not perform maintenance inside the chassis with ac power connected.

. Indicator Switch Assemblies HTA-8A24S1 ough S4 Removal and Replacement (fig. 3-35).

a. Tag and unsolder wires to switch terminals.

b. Pull bulb board straight out.

c. Turn screws inside switch to unlock switch, then pull switch through front panel.

d. Insert replacement switch without bulb board through panel and turn screws inside switch to lock switch in place.

e. Insert bulb board straight into switch.

f. Identify and solder wires to switch terminals.

. Switch Assemblies HTA-8A24S5 and S6 Re- al and Replacement. Removal and replacement dicator switch assembly S5 or S6 is the same as for ndicator switch assemblies in antenna control panel 8. Refer to paragraph 3-55.

. Indicator Assemblies HTA-8A24DS1 through Removal and Replacement. Removal and re- ment of any indicator assembly DS1 through DS10 e same as for the indicator assemblies in antenna ol panel 14A8. Refer to paragraph 3-56.

. Relay K1 through K15 and Diodes CR16 and 7 Removal and Replacement (fig. 3-14, sh 2). ys K1 through K7 are mounted on the top horizontal et, relays K8 through K14 are mounted on the bot- orizontal bracket, and relay K15 and diodes CR16 CR17 are mounted on the vertical bracket. Relays uckout items. To replace a diode (CR16 or CR17), er the leads and remove the diode. Solder the repla- t diode in place with the banded end toward the E3 contact.

. Circuit Breaker CB1 Removal and Replace- (fig. 3-14, sh 1 and 2). To replace CB1, perform eps described below.

. Tag and unsolder wires to terminals.

. Remove nut, lockwasher, and guard from front panel and remove circuit breaker.

. Install replacement circuit breaker in place with positioning pin in hole provided. Secure circuit breaker with guard, lockwasher, and nut.

. Identify and solder wires to terminals.

. Set circuit breaker CB1 to ON.

Power Supply HTA-8A24PS1 Removal and ement (fig. 3-14, sh 2). The 26 V dc power supply PS1 is bracket mounted to the interior mounting plate. Remove and replace power supply as follows:

a. Tag wires for identification and disconnect from the four power supply terminals.

b. Remove bolts, washers, and lockwashers that secure right angle bracket to right side of power supply.

c. Remove bolts, washers, and lockwashers that secure right angle bracket to mounting plate and remove right angle bracket.

d. Remove nuts, washers, and lockwashers that secure left angle bracket to left side of power supply and remove power supply from chassis.

e. Install replacement power supply (with power supply terminals facing left) on left angle brackets and secure with nuts, washers, and lockwashers.

f. Install right angle bracket on mounting plate and secure with mounting bolts, washers, and lockwashers.

g. Connect tagged electrical wires to applicable terminals on power supply.

3-84. Power Supply HTA-8A24PS1 Adjustment (fig. 3-14, sh 2). This paragraph provides voltage adjustment procedures for +26 V dc power supply PS1.

a. ***Test Equipment.*** Test equipment required for adjustment is a multifunction meter 3450-B, two test probes 1166-36, and a screwdriver.

b. ***Connections and Conditions.*** Adjustment of the +26 V dc power supply is accomplished with the power supply mounted in stow pin control/minor fault summary panel HTA-8A24. Prepare equipment for adjustment of power supply as follows:

(1) On front panel of stow pin control/minor fault summary panel HTA-8A24, set power circuit breaker to OFF.

WARNING

The stow pin control/minor fault summary panel contains 120 V ac. Use care when performing tests with the front panel open to prevent injury or death.

(2) Connect positive test probe of multifunction meter to pin 1 of terminal TB1 and negative test probe to pin 4 of terminal TB2.

c. ***Initial Control Settings.*** Set controls as follows.

Control	Position
Multifunction meter	
LINE	ON (UP)
FUNCTION	DC

Control	Position
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Stow pin control/minor fault summary panel	
Circuit breaker	ON

*d. **Adjustment Procedure.*** On left side of po supply, turn adjustment screw to obtain +26± V dc indication on multifunction meter. Afte justment, disconnect test equipment, close panel, and tighten cleats.

SECTION XV. MAINTENANCE OF DIRECT CURRENT CONTROL HTA-9

3-85. General. This section provides instructions for replacing assemblies, subassemblies, and modules of direct current control HTA-9. Major assemblies HTA-9A1 through 9A3 are replaced only as necessary for other maintenance. All components are accessible from front or rear of the cabinet. Removal and replacement procedures for components of major assemblies or cabinet-mounted components are presented in three separate categories; power supply control HTA-9A1, electronic control amplifier HTA-9A2, 9A3, and cabinet mounted units. Adjustment procedures are provided for power supplies and overvoltage protectors in the power supply control and amplifier functions of the electronic control amplifiers.

3-86. Power Supply Control HTA-9A1 Component Removal and Replacement. This paragraph provides replacement details for relays, circuit breakers, power supplies, overvoltage protectors, and fuseholders. Refer to figure 3-22 for parts location and identification.

WARNING

CONTACTOR circuit breaker HTA-9A1CB2 controls application of the 277/480 V ac, 3-phase input to the scr assemblies. Do not perform any maintenance inside the cabinet housing the scr assemblies while CONTACTOR circuit breaker CB2 is set to ON.

WARNING

Use extreme care when performing maintenance inside the cabinet housing direct current control HTA-9 with the door interlock switch in the override position. Very high ac voltages (277/480 V ac) are present and could cause injury or death.

*a. **Relays K1, K2, K3.*** Replacement of relay K1, K2, or K3 is accomplished as follows:

(1) At rear of panel, tag for identification and disconnect wires to relay.

(2) Remove four nuts, washers, and lockwa at rear of panel, and remove screw and wa from front panel; then remove relay.

(3) Install replacement relay in place. Inser screws through front panel and through c clamp (K3 only). Secure relay at rear of p with four hex nuts, lock washers, and washers.

(4) Identify and connect wires to relay.

*b. **Circuit Breakers CB1, CB2.*** Replacement o cuit breaker CB1 or CB2 is accomplished as fol

(1) Tag for identification and unsolder wi circuit breaker.

(2) Remove hex nut at front of panel and re circuit breaker at rear of panel.

(3) Install replacement circuit breaker in p (guide in hole) and secure with hex n front of panel.

(4) Identify and connect wires to circuit bre

*c. **Power Supplies PS1, PS2, PS3.*** Replacem any power supply PS1, PS2, or PS3 is accomplish follows.

(1) On power supply control front pan POWER SUPPLIES circuit break TRIPPED; on ac distribution box, se 208 VAC (no. 13) and 277/480 VAC (and 22) circuit breakers to OFF.

(2) Tag for identification and remove w bottom of power supply.

NOTE

The power supply must be supported from the rear of the panel when removing mounting screws.

(3) On front of power supply control, remo phillips-head screws, washers, and lo ers securing power supply to panel and r power supply.

(4) Loosen two captive screws securing eac voltage protector to power supply and r overvoltage protector(s). Retain over protector(s) for reuse.

(5) Perform power supply troubleshooting procedure if applicable. Refer to section VII, paragraph 3-36 for PS1, paragraph 3-37 for PS2, and paragraph 3-38 for PS3 troubleshooting. Replace faulty component. Power supply components removal and replacement procedures are provided by paragraphs 3-87 (PS1), 3-88 (PS2), and 3-89 (PS3).

(6) Install overvoltage protector on power supply and secure each with two captive screws.

(7) Install repaired or replacement power supply in place on back side of power supply control panel; insert four phillips-head screws on front side of panel, and tighten screws, washers, and lockwashers.

(8) Identify wires by tags and connect to power supply terminal strip.

(9) Adjust power supply voltage output as follows:

(a) Set multifunction meter controls as follows:

Control	Position
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT

(b) Connect multifunction meter test leads to power supply power output terminals +V and -V.

(c) On ac distribution box, set 120/208 VAC circuit breaker and 277/480 VAC circuit breakers to ON.

(d) On power supply control, set POWER SUPPLIES CIRCUIT breaker to ON.

(e) Using voltage adjustment control on front side of power supply PS1 or PS2, adjust output for applicable multifunction meter indication as follows: PS1, +5 V dc; PS2, +15 V dc and 15 V dc. On top side of power supply PS3, adjust output for multifunction meter indication of +15 V dc.

Overvoltage Protectors VR1 through VR4. Repla- of any overvoltage protector VR1 through VR4 plished as follows.

(1) Tag and disconnect two wires from power supply terminal board.

(2) Loosen two captive screws securing overvoltage protector to power supply and remove overvoltage protector.

(3) Install replacement overvoltage protector on power supply and tighten two captive screws.

(4) Identify and connect overvoltage protector wires to power supply terminal board.

(5) Adjust overvoltage protector for specified limit (para 3-90).

(6) Perform power supply output voltage adjustment (see step c(9) above).

e. Fuseholders XF1 through XF4. Replacement of any fuse holder XF1 through XF4 is accomplished as follows:

(1) Tag and remove wires at back of power supply control front panel.

(2) Remove four phillips-head screws, washers, and lockwashers on power supply control front panel.

(3) Install replacement fuse holder in place with guide slots and secure with four phillips head screws, washers, and lockwashers.

(4) Identify wires and connect to fuse holder.

3-87. +5 V DC Power Supply HTA-9A1PS1 Component Removal and Replacement. Removal and replacement procedures for components in power supply PS1 are described below. Refer to figure 3-24 for parts location and identification.

a. Power Supply Cover (fig. 3-24, sh 1). For access to the internal power supply parts, the power supply cover must be removed. Remove and replace it as follows:

(1) Remove six phillips-head screws from each side of power supply and remove cover.

(2) Replace cover on power supply and align with mounting holes on each side of supply. Secure cover with six phillips-head screws on each side of power supply.

b. Power Transformer T1 (fig. 3-24, sh 2 and 3). Remove and replace power transformer T1 as follows:

(1) Remove power supply cover (para 3-87a).

(2) Remove two phillips-head screws that secure pcb M. Fold PC board M over for access to transformer connections.

(3) Identify, unsolder, and disconnect wires connected to pcb M from power transformer T1.

(4) Identify, unsolder, and disconnect capacitor C10 and wires from terminal board A connected to power transformer T1.

(5) Remove nut and washers securing terminal board A to chassis and fold terminal board away from transformer.

(6) Remove two phillips-head screws that secure each side of power transformer T1 to power supply chassis.

(7) Remove power transformer T1.

(8) Install replacement power transformer T1 in power supply chassis so that mounting holes are aligned with mounting holes on chassis.

(9) Insert phillips-head screws in each power transformer mounting hole and secure to chassis.

(10) Install terminal board A in place and secure with washers and nut.

(11) Solder capacitor C10 and wires from terminal board A to identified terminals on power transformer T1.

(12) Identify and solder wires from power transformer T1 to applicable terminals on pcb M.

(13) Install pcb M in place and secure with two phillips-head screws.

(14) Replace cover on power supply (para 3-87**a**).

(15) Perform test procedures in section XXX of this chapter.

*c. **Filter Capacitor C6 (fig. 3-24, sh 2 and 3).*** Remove and replace filter capacitor C6 as follows:

(1) Remove power supply cover (para 3-87**a**).

(2) Place power supply chassis top-side-up on bench.

(3) Identify, unsolder, and disconnect wires from capacitor C6 to terminal board A.

(4) Noting polarity, remove capacitor C6 from mounting clamp and slide out of left side of power supply chassis.

(5) Observing polarity, slide replacement capacitor C6 in left side of power supply chassis and install in mounting clamp.

(6) Solder wires from identified terminals on terminal board A.

(7) Replace cover on power supply (para 3-87**a**).

(8) Perform test procedure in section XXX of this chapter.

*d. **Series Regulator Transistor Q2 (fig. 3-24, sh 3).*** Remove and replace series regulator transistor Q2 as follows:

(1) Remove power supply cover (para 3-87**a**).

(2) Remove four phillips-head screws that secure front plate. Fold front plate away from power supply chassis for access to transistor connections.

(3) Tag for identification and unsolder two wires on transistor Q2.

(4) Remove hex nuts, lock washers, and terminal lug from back of mounting screws that secure transistor Q2 to front plate.

(5) Remove transistor Q2 from mounting screws. Remove and inspect insulating wafer. Replace if cracked.

(6) Coat both sides of insulating wafer with heat sink compound (Dow Corning no. 340 silicone grease, or equivalent).

(7) Install insulating wafer and replacement transistor Q2 on mounting screws.

(8) Install terminal lug, lockwashers, and hex nut on mounting screws to secure transistor Q2 to front plate.

(9) Solder tagged wires to applicable pins on bottom side of transistor Q2.

(10) Install front plate with transistor Q2 on p supply chassis so that mounting hole aligned.

(11) Secure front plate to power supply ch with four phillips-head screws.

(12) Install cover on power supply (para 3-8

(13) Perform test procedures in section XX this chapter.

*e. **Printed Circuit Board Components.*** When a d ctive component on the printed circuit board is r replaced, observe the following maintenance techni

(1) When unsoldering a component, never p force it loose; unsolder component by wicking process described below:

  (**a**) Select a 3/16-inch tinned copper brai use as a wick; if braid is not available lect AWG no. 17 or no. 16 stranded with 1/2-inch insulation removed.

  (**b**) Dip wick in liquid rosin flux.

  (**c**) Place wick on soldered connection apply soldering iron to wick.

  (**d**) When sufficient amount of solder f onto wick, freeing the component, sim neously remove iron and wick.

(2) When soldering semiconductor devices, lead being soldered with a pair of pliers place a commercial heat sink device betw the component and the solder joint.

(3) Always use a heat sink when soldering tra tors; a transistor pad with mounting feet effective heat sink.

(4) If foil is intact, but not covered with solder is a good contact. Do not attempt to cover solder.

(5) Broken or damaged printed wiring is u the result of an imperfection, strain, or less soldering. To repair small breaks, short piece of hook-up wire to bridge break, hold wire in place, and flow s along length of wire so that it becomes pa the circuitry.

(6) Check and clean all replacement comp leads prior to soldering, regardless of appearance.

(7) Use smooth finished tools for bending avoid use of any sharp-edged tool that pinch or break the lead. Leave a distan at least twice the diameter of the lead end seal of component to start of the This rule also applies to all components soldered leads, such as tantalum capa

(8) Position replacement component in place as removed component. Do not components on top of another componen sition replacement component so that identification mark, such as part nu symbol, value, etc., is readily visible.

(9) Observe polarity of replacement diodes, transistors, and electrolytic and tantalum capacitors.

(10) Perform test procedures in section XXX of this chapter.

3-88. Dual 15 V DC Power Supply HTA-9A1PS2 Component Removal and Replacement. Removal and replacement procedures for components in power supply PS2 are described below. Refer to figure 3-26 for parts location and identification.

a. Power Supply Cover (fig. 3-26, sh 1). For access to the internal power supply parts, the power supply cover must be removed. Remove and replace it as follows:

(1) Remove six phillips-head screws from end side of power supply and remove cover.

(2) Replace cover on power supply and align with mounting holes on each side of supply. Secure cover with six phillips-head screws on each side of power supply.

b. Power Transformer T1 (fig. 3-26, sh 2, 3, and 4). Remove and replace power transformer T1 as follows:

(1) Remove power supply cover (para 3-88*a*).

(2) Remove two phillips-head screws that secure pcb M and two screws that secure TB1. Fold pcb M over for access to transformer connections.

(3) Remove cable tie-wrap from pcb M.

(4) Identify, unsolder, and disconnect wires connected to pcb M from power transformer T1.

(5) Remove two phillips-head screws that secure pcb S and two screws that secure TB101. Fold pcb S over for access to transformer connections.

(6) Remove cable tie-wrap from pcb S.

(7) Identify, unsolder, and disconnect wires connected to pcb S from power transformer T1.

(8) Remove two phillips-head screws that secure each side of transformer T1 to power supply chassis.

(9) Remove power transformer T1.

(10) Install replacement power transformer in power supply chassis so that mounting holes are aligned with mounting holes on chassis.

(11) Insert phillips-head screws in each power transformer mounting hole and secure to chassis.

(12) Solder transformer wires to applicable destination points on pcb M and S.

(13) Replace cable tie-wraps on pcb M and S.

(14) Install pcb M and S and terminal boards TB1 and TB101 in place and secure with phillips-head screws.

(15) Replace cover on power supply (para 3-88*a*).

(16) Perform test procedure in section XXXI of this chapter.

c. Filter Capacitor C6 and C106. Remove and replace filter capacitor C6 or C106 as follows:

(1) Remove power supply cover (para 3-88*a*).

(2) Remove two phillips-head screws that secure pcb M or S and two phillips-head screws that secure TB1 or TB101. Fold pcb over for access to capacitor C6 or C106.

(3) Identify destination points of wires connected to capacitor. Unsolder wires and remove capacitor.

(4) Install replacement capacitor and solder to identified destination points on pcb M or S.

(5) Install pcb and terminal board in place and secure with four philips-head screws.

(6) Replace cover on power supply (para 3-88*a*).

(7) Perform test procedure in section XXXI of this chapter.

d. Series Regulator Transistor Q2 and Q102 (fig. 3-26,sh 3). Remove and replace series regulator transistor Q2 or Q102 as follows:

(1) Remove power supply cover (para 3-88*a*).

(2) Remove four phillips-head screws that secure front plate. Fold front plate away from power supply chassis for access to transistor connections.

(3) Tag for identification and unsolder two wires on bottom side of transistor Q2 or Q102.

(4) Remove hex nuts, lockwashers, and terminal lug from back of mounting screws that secure transistor Q2 or Q102 to front plate.

(5) Remove transistor from mounting screws. Remove and inspect insulating wafer. Replace if cracked.

(6) Coat both sides of insulating wafer with heat sink compound (Dow Corning no. 340 silicone grease, or equivalent).

(7) Install insulating wafer and replacement transistor on mounting screws.

(8) Install terminal lug, lockwashers, and hex nut on mounting screws to secure transistor to front plate.

(9) Solder tagged wires to applicable pins on bottom side of transistor Q8.

(10) Install front plate with transistor Q2 on power supply chassis so that mounting holes are aligned.

(11) Secure front plate to power supply chassis with four phillips-head screws.

(12) Install cover on power supply (para 3-88*a*).

(13) Perform test procedures in section XXXI of this chapter.

e. Printed Circuit Board Components. When a defective component on the printed circuit board is to be replaced, observe the maintenance techniques described below.

(1) When unsoldering a component, never pry or force it loose; unsolder the component by using the wicking process described below:
  (a) Select a 3/16-inch tinned copper braid for use as a wick; if braid is not available, select AWG no. 16 stranded wire with 1/2-inch of insulation removed.
  (b) Dip wick in liquid rosin flux.
  (c) Place wick on soldered connection and apply soldering iron to wick.
  (d) When sufficient amount of solder flows onto wick, freeing component, simultaneously remove iron and wick.

(2) When soldering semiconductor devices, hold the lead being soldered with a pair of pliers or place a commercial heat sink device between the component and the solder joint.

(3) Always use a heat sink when soldering transistors; a transistor pad with mounting feet is an effective heat sink.

(4) If foil is intact, but not covered with solder, it is a good contact. Do not attempt to cover with solder.

(5) Broken or damaged printed wiring is usually the result of an imperfection, strain, or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

(6) Check and clean all replacement component leads prior to soldering, regardless of visual appearance.

(7) Use smooth finished tools for bending leads; avoid use of any sharp-edged tool that may pinch or break the lead. Leave a distance of at least twice the diameter of the lead from the end seal of the component to the start of the bend. This rule also applies to all components with soldered leads, such as tantalum capacitors.

(8) Position replacement component in the same place as the removed component. Do not mount component on top of another component. Position replacement component so that any identification mark, such as the part number, symbol, value, etc., is readily visible.

(9) Observe polarity of replacement diodes, transistors, and electrolytic and tantalum capacitors.

(10) Perform test procedure in section XXXI of this chapter.

3-89. +15 V DC Gate Power Supply HTA-9A1PS3 Component Removal and Replacement. Removal and replacement procedures for components in power supply PS3 are described below. Refer to figure 3-28 for parts location and identification.

a. Power Supply Cover Removal and Repla
(fig. 3-28, sh 1). For access to the internal power
parts, the power supply cover must be removed. T
move and replace it, proceed as follows:

(1) On front of power supply, remove the
three phillips-head screws.

(2) Place power supply bottom-side-up on
Remove two phillips-head screws on
side.

(3) For access to power supply components,
fully slide cover away from chassis un
tended to cable length.

(4) To replace bottom cover, place it on
supply and align with mounting holes on
and bottom of power supply.

(5) Secure bottom cover to supply with two
llips-head screws on bottom and three on
er front of power supply.

b. Power Transformer T1 (fig. 3-28, sh 1
Remove and replace power transformer T1 as fo

(1) Remove power supply cover (para
(2) Tag destination points of wires connec
power transformer for identification.
(3) Unsolder and disconnect wires connec
transformer.
(4) Remove power transformer cable tie-
(5) Remove nut and lockwasher from each
four mounting bolts.
(6) Remove transformer from chassis.
(7) Install replacement power transform
power supply chassis so that mounting
protrude through mounting holes on
(8) Install lockwasher and nut on each mo
bolt to secure transformer to chassis.
(9) Solder transformer wires to applicable
d destination points.
(10) Replace cover on power supply (para
(11) Perform test procedures in section XX
this chapter.

c. Filter Capacitor C6 and C7 (fig. 3-28, sh 1
To remove and replace filter capacitor C6 or C7,
as follows:

(1) Remove power supply cover (para
(2) Place power supply chassis left-side
bench.
(3) Remove four corner screws that sec
board A. Fold PC board over for ac
capacitor.
(4) Identify destination points of wires con
to filter capacitor. Unsolder wires.
(5) Remove capacitor from mounting
(6) Install replacement filter capacitor in
ing clamps.
(7) Solder capacitor wires to identified
tion points.

(8) Secure PC board A with four corner screws.
(9) Install cover on power supply (para 3-89*a*).
(10) Perform test procedure in section XXXII of this chapter.

d. *Series Regulator Transistors Q3 and Q4 (fig. 3-28,* and 5). To remove and replace series regulator tran-
r Q3 or Q4, proceed as follows:

(1) Remove power supply cover (para 3-89*a*).
(2) Place power supply bottom-side-up on bench.
(3) On front cover of power supply, remove eight hex head bolts that secure transistor Q3 or Q4 heat sink assembly and four phillips-head screws that secure terminal board C and thermostat S1. Remove cable tie-wraps.
(4) Remove transistor Q3 and Q4 heat sink assemblies from cover.
(5) Tag for identification and unsolder two wires on each side of transistor Q3 or Q4.
(6) Remove hex nut, washers, and terminal lug from back of the two mounting screws that secure transistor Q3 or Q4 to the heat sink assembly.
(7) Remove transistor Q3 or Q4 from mounting screws. Remove and inspect insulating wafer for cracks. Replace if cracked.
(8) Coat both sides of insulating wafer with heat sink compound (Dow Corning No. 340 silicone grease or equivalent).
(9) Install insulating wafer and replacement transistor on heat sink mounting screws.
(10) Install terminal lug, washers, and hex nuts on mounting screws to secure transistor to heat sink assembly.
(11) Solder tagged wires to applicable pins on bottom side of the transistor.
(12) Install transistor Q3 and Q4 heat sink assemblies with terminal board C and thermostat S1 on interior side of front cover and secure with four phillips-head screws and eight hex head bolts.
(13) Secure cable tie-wraps.
(14) Replace power supply cover (para 3-89*a*).
(15) Perform test procedures in section XXXII of this chapter.

Bridge Rectifiers CR2 through CR5 (fig. 3-28, sh 3). To remove and replace a bridge rectifier,
d as follows:

(1) Remove power supply cover (para 3-89*a*).
(2) Place power supply top side up on bench.
(3) Identify and unsolder wire connected to rectifier anode.
(4) Place power supply bottom side up on bench and identify wires connected to rectifier cathode.
(5) Remove hex nut and wire from rectifier stud. Remove rectifier from power supply.
(6) Remove and inspect mica insulating washer. Replace if cracked.
(7) Place mica insulating washer over rectifier stud and insert rectifier stud through mounting hole on power supply chassis.
(8) Install identified wire and hex nut on rectifier stud.
(9) Solder identified electrical wire to rectifier anode.
(10) Replace power supply cover (para 3-89*a*).
(11) Perform test procedures in section XXXII of this chapter.

f. Printed Circuit Board Components. When a defective component on the printed circuit board is to be replaced, observe the maintenance techniques described below.

(1) When unsoldering a component, never pry or force it loose; unsolder the component by using the wicking process described below:
    (a) Select a 3/16-inch tinned copper braid for use as a wick; if braid is not available, select AWG No. 16 stranded wire with 1/2 inch of insulation removed.
    (b) Dip wick in liquid rosin flux.
    (c) Place wick onto soldered connection and apply soldering iron onto wick.
    (d) When sufficient amount of solder flows onto wick, freeing the component, simultaneously remove iron and wick.
(2) When soldering semiconductor devices, hold the lead being soldered with a pair of pliers or place a commercial heat sink device between the component and the solder joint.
(3) Always use a heat sink when soldering transistors; a transistor pad with mounting feet is an effective heat sink.
(4) If foil is intact, but not covered with solder, it is a good contact. Do not attempt to cover with solder.
(5) Broken or damaged printed wiring is usually the result of an imperfection, strain, or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.
(6) Check and clean all replacement component leads prior to soldering, regardless of visual appearance.
(7) Use smooth finished tools for bending leads; avoid use of any sharp-edged tool that may pinch or break the lead. Leave a distance of at least twice the diameter of the lead from the end seal of the component to the start of the bend. This rule also applies to all components with soldered leads, such as tantalum capacitors.

(8) Position the replacement component in the same place as the removed component. Do not mount component on top of another component. Position the replacement component so that any identification mark, such as the part number, symbol, value, etc., is readily visible.

(9) Observe the polarity of replacement diodes, transistors, and electrolytic and tantalum capacitors.

(10) Perform the test procedures in section XXXII of this chapter.

3-90. Overvoltage Potectors HTA-9A1VR1 through VR4 Adjustment. This paragraph describes test equipment, connections and conditions, initial control settings, and procedures for adjustment of direct current control HTA-9 power supply overvoltage protectors HTA-9A1VR1 through VR4.

a. Test Equipment. The following test equipment is required for adjustment.

(1) Multifunction meter, Hewlett-Packard 3450B

(2) Test leads, Pomona 1166-36-B and 1166-36-R (banana plug to alligator clip).

b. Connections and Conditions. Adjustment of the overvoltage protector is accomplished with the overvoltage protector mounted on the power supply in direct current control HTA-9 and connected in a normal, no-load configuration. Prepare equipment for adjustment as follows.

(1) On front panel of power supply control HTA-9A1, set POWER SUPPLIES circuit breaker CB1 to TRIPPED.

(2) Inside cabinet, at rear of the power supply control (fig. 3-22, sh 3), tag and disconnect wires connected to terminals 6 and 7 (or 14 and 15) of power supply terminal board TB1 (or TB101). Do not disconnect wires connected to overvoltage protector or jumpers between terminals 6 and 7 (or 14 and 15).

c. Initial Control Settings. Set controls as follows:

Control	Position
Multifunction meter	
LINE	ON (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Overvoltage protector	
ADJUST	Full cw (approximately 20 turns)

d. Overvoltage Protector VR1 Adju *Procedure.* Perform overvoltage protector VR1 adj ment procedure as follows:

(1) Connect negative (black) test lead from X terminal on multifunction meter to te nal 3 (or 11) and positive (red) test lead red X terminal to terminal 7 (or 15) on p supply terminal board.

(2) On power supply control HTA-9A1 front el, set POWER SUPPLIES circuit break ON.

(3) Adjust power supply VDC ADJ control f indication of 6.75 V dc on multifunction ter.

(4) While observing multifunction meter, s turn overvoltage protector ADJUST co counterclockwise until power supply ou voltage drops. Overvoltage protection po now set.

(5) Rotate power supply VDC ADJ control counterclockwise.

(6) Set POWER SUPPLIES circuit break TRIPPED.

(7) Identify and connect output leads to term 6 and 7 on power supply terminal board

(8) Set POWER SUPPLIES circuit breake ON.

(9) Using power supply VDC ADJ control, a power supply voltage to 5 ±0.15 V dc, as cated on multifunction meter.

(10) Set POWER SUPPLIES circuit break TRIPPED.

(11) Disconnect test equipment from unit u test.

e. Overvoltage Protector VR2, VR3, and VR4 *justment Procedure.* Perform overvoltage protector V VR3, or VR4 adjustment as follows:

(1) Connect negative (black) test lead from X terminal on multifunction meter to te nal 3 (or 11) and positive (red) test lead red X terminal to terminal 7 (or 15) on p supply terminal board.

(2) On power supply control HTA-9A1 front el, set POWER SUPPLIES circuit break ON.

(3) Adjust power supply VDC ADJ control f indication of 18.25 V dc on multifunction ter.

(4) While observing multifunction meter, s turn the ADJUST control countercloc until power supply output voltage d Overvoltage protection point is now set.

(5) Rotate power supply VDC ADJ control counterclockwise.

(6) Set POWER SUPPLIES circuit breaker to TRIPPED.

(7) Identify and connect output leads to terminals 6 and 7 (or 14 and 15) on power supply terminal board.

(8) Set POWER SUPPLIES circuit breaker to ON.

(9) Using power supply VDC ADJ control, adjust output voltage to 15 ±0.15 V dc, as indicated on multifunction meter.

(10) Set POWER SUPPLIES circuit breaker to TRIPPED.

(11) Disconnect test equipment from unit under test.

3-91. Power Supplies HTA-9A1PS1, 9A1PS2 Voltage Adjustments. This paragraph provides preliminary procedures and voltage adjustment procedures for +5 and dual 15 V dc power supplies PS1 and PS2.

a. Test Equipment and Materials. Table 3-28 lists the test equipment required for power supply output voltage adjustment.

Table 3-28 Test Equipment Required for Power Supply HTA-9A1PS1, 9A1PS2, 9A1PS3 Output Voltage Adjustment

Common name	Part/model no.	Qty	Manufacturer
C Line Cord	17449-S	1	Belden
apter, Banana Jack to Minigator Clip	3448	3	Pomona
apter, Single Banana Plug to Binding Post	2894	2	Pomona
ter, Multifunction	3450B	1	Hewlett-Packard
ammeter, Volt-Ohm- (VOM)	260-6	1	Simpson
Lead, Banana Plug to Banana Plug	B-48(B)	1	Pomona
Lead, Banana Plug to Banana Plug	B-48(R)	1	Pomona
Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona
Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
former, Variable	3PN2210	1	Staco

b. Test Connections and Conditions. Prior to per- ing the adjustment, prepare the equipment as ws:

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF.

(3) To adjust power supply HTA-9A1PS1, connect equipment as shown in figure 3-23, except dual-trace oscilloscope is not required. To adjust power supply HTA-9A1PS2, connect equipment as shown in figure 3-25 except dual-trace oscilloscope is not required.

(4) Connect multifunction meter positive (red) test lead to TB1 terminal 6 (or 14) and negative (black) test lead to TB1 terminal 4 (or 12) power supply being adjusted.

c. Initial Test Equipment Settings. Initial test equipment settings for the adjustment procedure are as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT

Control	Position
Variable transformer	
Power switch	ON

d. Adjustment Procedure. Using VDC ADJ control on side of power supply, adjust output voltage for a multifunction meter indication as follows: PS1, 5 ±0.05 V dc; PS2 (M and S), 15 ±0.15 V dc.

3-92. +15 V DC Gate Power Supply HTA-9A1PS3 O current Adjustment. Overcurrent adjustment is requ when transistor Q3 or Q4, resistor R6, R7, R9, R11, R or R21, or integrated circuit IC1 is replaced and vo and current indication do not reflect maximum ra

a. Test Equipment and Materials. The test equip and materials required to adjust +15 V dc gate po supply HTA-9A1PS3 overcurrent control R13 are liste table 3-29.

Table 3-29 Test Equipment Required for 15 V DC Gate Power Supply HTA-9A1PS3 Overcurrent Adjustment

Common name	Part/model no.	Qty	Manufactur
AC Line Cord	17449-S	1	Belden
Adapter, AC, 3-Wire to 2-Wire	785-0419	1	Allied
Adapter, Banana Jack to Minigator Clip	3448	7	Pomona
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Ammeter, DC, Multirange	931-2902001	1	Weston Instruments
Meter, Multifunction	3450B	1	Hewlett-Packard
Milliammeter, Volt-Ohm- (VOM)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Rheostat, Carbon Compression	82905	1	Central Scientific
Test Lead, Banana Plug to Alligator Clip	1166-36-B	1	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(B)	3	Pomona
Test Lead, Banana Plug to Banana Plug	B-48(R)	2	Pomona
Test Lead, BNC Plug to Double Banana (44 in.)	11001A	1	Hewlett-Packard
Test Lead, Spade Lug to Banana Plug	1370-24-B	1	Pomona
Test Lead, Spade Lug to Banana Plug	1370-24-R	1	Pomona
Test Lead, Spade Lug to Spade Lug	1743-36-R	1	Pomona
Transformer, Variable	3PN2210	1	Staco

b. Test Connections and Conditions. Adjustment of the overcurrent control is accomplished in a bench test setup. Prior to performing the adjustment, prepare the equipment as follows:

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to source. Set power switch to ON and o that indicator lights. Adjust variable former for 115 V ac indication on vo variable transformer power switch to O

sition. Disconnect vom.

(3) Remove power supply cover (para 3-89a).

(4) Locate potentiometer R13 on printed circuit board A (fig. 3-28, sh 4). The adjustable (inner) section of R13 is solder sealed to the outer casing. This seal prevents inadvertent movement of the wiper following factory adjustment. Unsolder the seal and adjust R13 to the full CW position.

(5) Connect equipment as shown in figure 3-37.

(6) Adjust carbon compression rheostat for maximum resistance (fully ccw).

c. ***Initial Test Equipment Settings.*** Initial test equipnt settings for the adjustment procedure are as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Oscilloscope	
POWER	On (pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe signal
CH1 AC-GND-DC	AC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER SLOPE and LEVEL	As required for stable display
Variable transformer	
Power switch	On

d. ***Adjustment Procedure.*** Perform the adjustment lows:

(1) Disconnect load from power supply by disconnecting test lead from negative terminal of dc ammeter.

(2) On front adjust side of power supply (fig. 3-28, sh 1) control for an indication of 14.25 V dc on the multifunction meter.

(3) Reconnect test lead to negative terminal of dc ammeter as shown in figure 3-37.

(4) Adjust rheostat for 3.5 A (110 percent of 40C rating for unit) indication on ac ammeter.

(5) Observe oscilloscope and adjust R13 on circuit card in a ccw direction until output ripple increases sharply and oscilloscope pattern changes.

(6) Set variable transformer power switch to OFF.

(7) On power supply printed circuit board A, solder seal the adjustable (inner) section of R13 to the outer casing, to prevent further movement of wiper. Increase resistance of carbon compression rheostat (rotate ccw).

(8) After sealing, check setting of R13 by setting variable transformer power switch to ON. Adjust rheostat to produce a load current of 3.5 A while observing the oscilloscope and current meter. When load current indication on current meter reaches 3.5 A, verify that output ripple increases sharply and oscilloscope pattern changes. If indications on oscilloscope are not as specified, set variable transformer power switch to OFF, break the seal on R13, set variable transformer to ON, and repeat steps (1) through (8).

3-93. Power Supply HTA-9A1PS3 Voltage Adjustments. This paragraph provides preliminary procedures and voltage adjustment procedures for +15 V dc gate power supply HTA-9A1PS3.

a. ***Test Equipment and Materials.*** The test equipment and materials required for power supply output voltage adjustment is listed in table 3-28.

b. ***Test Connections and Conditions.*** Before performing the adjustment, prepare the equipment as follows:

(1) Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

(2) Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

(3) Connect equipment as shown in figure 3-27, except dual-trace oscilloscope is not required.

(4) Connect multifunction meter positive (red) test lead to TB1 terminal 6 and negative (black) test lead to TB1 terminal 4 on power supply.

c. ***Initial Test Equipment Settings.*** Initial test equipment settings for the adjustment procedure are as follows:

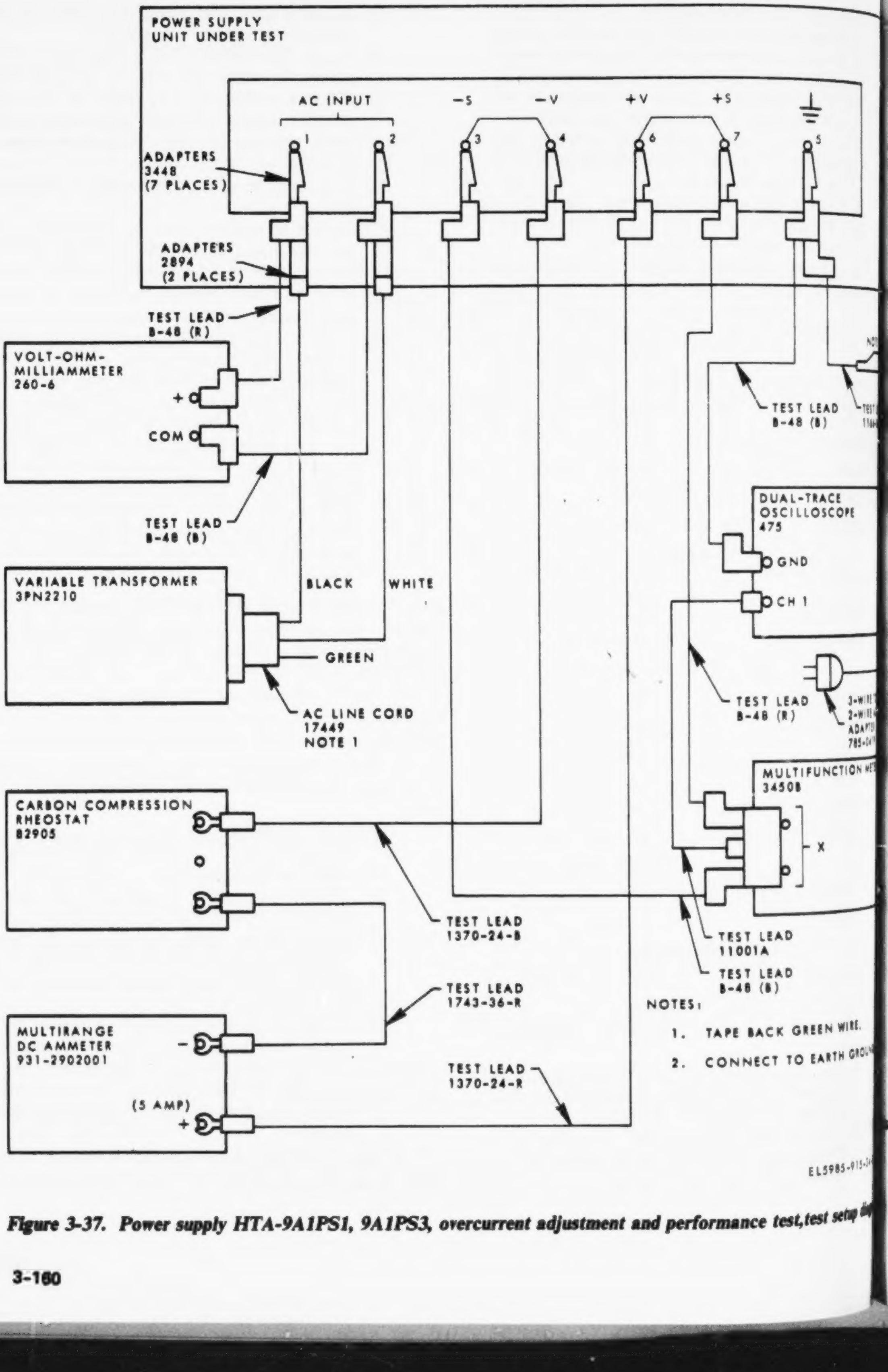

POWER SUPPLY
UNIT UNDER TEST
AC INPUT
−S
−V
+V
+S
1
2
3
4
6
7
5
ADAPTERS
3448
(7 PLACES)
ADAPTERS
2894
(2 PLACES)
TEST LEAD
B-48 (R)
VOLT-OHM-
MILLIAMMETER
260-6
+
COM
TEST LEAD
B-48 (B)
VARIABLE TRANSFORMER
3PN2210
BLACK
WHITE
GREEN
AC LINE CORD
17449
NOTE 1
CARBON COMPRESSION
RHEOSTAT
82905
TEST LEAD
1370-24-B
TEST LEAD
1743-36-R
MULTIRANGE
DC AMMETER
931-2902001
−
(5 AMP)
+
TEST LEAD
1370-24-R
TEST LEAD
B-48 (B)
DUAL-TRACE
OSCILLOSCOPE
475
GND
CH 1
TEST LEAD
B-48 (R)
MULTIFUNCTION
34508
X
TEST LEAD
11001A
TEST LEAD
B-48 (B)
NOTES:
1. TAPE BACK GREEN WIRE.
2. CONNECT TO EARTH
EL5985-915-

Figure 3-37. Power supply HTA-9A1PS1, 9A1PS3, overcurrent adjustment and performance test,test setup

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Variable transformer	
Power switch	ON

d. Adjustment Procedure. Using VDC control on front side of power supply, adjust output voltage for a 15 ±0.15 V dc indication on multifunction meter.

3-94. Electronic Control Amplifier HTA-9A2, 9A3 Removal and Replacement. This paragraph provides instructions for removing and replacing components and assemblies on either the elevation or azimuth electronic control amplifier A2 or A3. Refer to figure 3-20 for parts location diagram.

WARNING

CONTACTOR circuit breaker HTA-9A1CB2 controls application of the 277/480 V ac, 3-phase input to the scr assemblies. Do not perform any maintenance inside the cabinet with CONTACTOR circuit breaker CB2 set to ON.

WARNING

Use extreme care when performing maintenance inside the cabinet housing direct current control HTA-9 with the door interlock switch in the override position. Very high ac voltages (277/480 V ac) are present which could cause injury or death.

NOTE

When the circuit card is repaired or replaced on either electronic control amplifier, the adjustment procedure (para 3-95 through 3-97) must be performed prior to operation of the direct current control.

a. Circuit Card Assembly A1. Replace circuit card assembly A1 as follows.

(1) Disconnect two connectors at top and one connector at bottom of circuit card.

(2) Loosen nine captive screws and carefully remove circuit card assembly.

(3) For repair of defective circuit card, refer to higher level maintenance.

(4) Install repaired or replacement circuit card on electronic control amplifier front panel standoffs and secure with nine captive screws.

(5) Connect two connectors at top and one connector at bottom of assembly.

(6) Perform integrator limit adjustment (para 3-95), tachometer balance adjustment (para 3-96), and dc offset adjustment (para 3-97).

(7) Perform the direct current control HTA-9 performance test described in section XXVII.

b. SCR Assembly A2 through A7. The following procedure is typical for any scr assembly A2 through A7. Harness attachments to the scr assemblies are varied. When a procedure specifies removing a cable, harness, or interconnect strap attachment, it implies removal of all such attachments as necessary. A cable attachment consists of a terminal lug, a hex nut, and a flat washer. A harness attachment consists of a loop clamp, a hex nut, a lockwasher, one or two flat washers, and a bolt. An interconnect strap attachment consists of a wire braid, a hex nut, a lockwasher, a flat washer, and a bolt.

(1) Tag for identification and disconnect external wires to gate driver terminals.

(2) Remove harness attachment from scr assembly to be removed. Let harness attachment hang loose.

(3) Remove ac input cable attachment at scr assembly.

(4) Remove interconnect strap attachment from scr assembly.

(5) Release four knurled, slotted fasteners that secure scr assembly to electronic control amplifier and carefully pull scr assembly straight out.

(6) For scr assembly repair, refer to higher level maintenance.

(7) Install repaired or replacement scr assembly in place on back side of electronic control amplifier and attach with four knurled, slotted fasteners.

(8) Attach interconnect strap attachment to scr assembly.

(9) Install ac input cable attachment to scr assembly.

(10) Install harness attachment on scr assembly corner post.

(11) Identify wires by tags and connect to gate driver terminals.

(12) Perform electronic control amplifier performance test described in section XXVII.

c. Transformer T1. Replace transformer T1 as follows.

(1) Tag for identification and disconnect wires from transformer terminal lugs at rear of front panel.
(2) Remove four hex nuts, lockwashers, and flat washers from transformer studs and remove transformer.
(3) Install replacement transformer on front panel by inserting studs through mounting holes and attaching with four hex nuts, lockwashers and flat washers.
(4) Identify and attach wires to terminal lugs on transformer.

*d. **Fuseholders XF1 through XF3.*** Replacement of any fuseholder XF1 through XF3 is accomplished as follows.

(1) Tag and remove wires to fuseholder at rear of electronic control amplifier front panel.

(2) Remove four phillips-head screws on electronic control amplifier front panel and remove fuseholder.

(3) Install replacement fuseholder in place and secure with four phillips-head screws.

(4) Identify wires by tags and connect to fuseholder.

*e. **Fuses F4 through F9.*** Replacement of any fuse F4 through F9 is accomplished as follows.

(1) Remove two hex nuts and washers, lift off, and discard fuse.
(2) Remove spare (as in step 1) from cabinet side strut and install replacement fuse on block fuseholder XF4-XF9. Secure with two hex nuts and washers.

*f. **Thermal Relay K1, K2.*** Replacement of thermal relay K1 or K2 is accomplished as follows.

(1) Remove two hexhead screws that secure set screw terminal to thermal relay.
(2) Tag for identification and remove wires from C and NC contact points.
(3) Remove hex nut, lockwasher, and flat washer at top of thermal relay. Remove phillips-head screw and flat washer at front of panel.
(4) Loosen hex nut at bottom of thermal rela lift relay up and out.
(5) Remove relay heater element from the relay, paragraph *g*(1) below, and retai reuse.
(6) Install replacement thermal relay in plac secure with hex nut, lockwasher, and washer.
(7) Insert phillips-head screw (with flat wa through panel and to mounting hole of mal relay. Secure with hex nut, lockwa and flat washer.
(8) Install relay heater element (para *g*(2) ow).
(9) Identify and connect wires to C and NC tact points.
(10) Install setscrew terminals, with attached, at points A and B and secure hexhead screws.

*g. **Relay Heater Element HR1/HR2.*** Replace heater element HR1 or HR2 as follows.

(1) Remove two screws securing relay heate ment to thermal relay. Discard relay element if bent or defective.
(2) Install replacement relay heater elem thermal relay and secure with two s

3-95. Electronic Control Amplifier HTA-9A2, Integrator Limit Adjustment. After repair or re ment of an electronic control amplifier circuit ca sembly A1, perform the following preliminary adjustment procedures on the applicable electroni trol amplifier.

*a. **Test Equipment.*** Test equipment required just the integrator limits is listed in table 3-30.

Table 3-30 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Integrator Limit Adjustment

Common name	Part/model no.	Qty	Manufactur
Adapter, AC, 3-Wire to 2-Wire	785-0419	1	Allied
Adapter, BNC Plug to Dual Binding Post	103-0035-00	2	Tektronix
Adapter, 14 or 16 Pin DIP Test Clip	3916	1	Pomona
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Test Probe	1986-36-B	2	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-R	2	Pomona

Table 3-30 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Integrator Limit Adjustment - Continued

Common name	Part/model no.	Qty	Manufacturer
Lead, Mini Test Clip to Mini Test Clip	3781-12	2	Pomona

b. ***Test Connections and Conditions.*** Perform the wing operations to prepare direct current control A-9 for integrator limit adjustment. Adjustment test locations are shown on figure 3-17.

(1) Affix 3916 adapter to integrated circuit U7 on A1 (figure 3-38). Connect the 3781-12 test leads from pin 8 to 7 and from pin 11 to 7.

(2) Connect dual-trace oscilloscope to ac source. Set oscilloscope controls as follows.

Control	Position
POWER	ON (pull)
VERT MODE	ALT
VOLTS/DIV	As required for both channels
HORIZ DISPLAY	A
TRIG MODE	NORMAL
INPUT COUPLING	DC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER-SLOPE AND LEVEL	As required for stable display
TRIGGER HOLD-OFF	NORM
X MAG	OFF (out)

(3) Using POSITION controls for both channels, adjust both traces to overlap on base line.

(4) Connect dual-trace oscilloscope to circuit card assembly no. 1 test points 15 and 27 as shown in figure 3-39.

c. ***Initial Control Settings.*** On circuit card assembly HTA-9A2A1, 9A3A1, set LOCAL switch to OFF and OPERATE switch to NORMAL.

d. ***Adjustment Procedure.*** Adjust the integrator limits as follows.

(1) Set OPERATE switch S2 to LOCAL, LOCAL switch S1 to SLEW, and set SLEW potentiometer R110 to full counterclockwise position. Vertical deflection for both channels must be equal and the peak of the 60 Hz waveform on CHAN 1 must be displayed. Adjust the ITNEG LIM ADJ R85 for a CH2 waveform 0.2 V dc ±10 pct down from the peak of the CH1 sine wave.

(2) Return LOCAL switch to OFF and OPERATE switch to NORMAL.

(3) Remove 3916 adapter from IC V7.

3-96. Electronic Control Amplifier HTA-9A2, 9A3, Tachometer Balance Adjustment. After repair or replacement of an electronic control amplifier circuit card assembly A1, perform the following preliminary and adjustment procedures on the applicable electronic control amplifier.

a. ***Test Equipment and Materials.*** Test equipment required to adjust the tachometer balance is listed in table 3-31.

Table 3-31 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Tachometer Balance Adjustment

Common name	Part/model no.	Qty	Manufactur
Adapter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona

b. ***Test Connections and Conditions.*** Adjustment test point locations are shown on figure 3-17. Adjustment controls are shown on figure 3-38. Connect dual-trace oscilloscope channel 1 to circuit card assembly no. 2 test points 24 and 35. (See figure 3-39 for typical corrections.)

c. ***Initial Control Settings.*** On circuit card assembly A1, set OPERATE switch to LOCAL and LOCAL switch to SLEW. On dual-trace oscilloscope, set controls as follows.

Control	Position
VERT MODE	CH1
CH1 VOLTS/DIV	As required
CH1 AC-GND-DC slide control	DC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
INPUT COUPLING	DC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER-SLOPE and LEVEL	As required for stable display
TRIGGER HOLD OFF	NORM
10x MAG	OFF (out)

d. Adjustment Procedure. Adjust tachometer ance as follows:

(1) Connect CH1 input of dual-trace oscill to TP24.

(2) Set SLEW potentiometer R110 to ap mately 25 pct of its clockwise or counte wise rotation. Adjust TACH 1 TRIM or TACH 2 TRIM R151 for an oscil indication of 0 V dc ±10 mV dc; DO ADJUST BOTH.

(3) Return LOCAL switch to OFF and O ATE switch to NORMAL.

3-97. Electronic Control Amplifier HTA-9A2 DC Offset Adjustment. After repair or replace an electronic control amplifier circuit card assemb perform the following preliminary and adjustment dures on the applicable electronic control amplifi

a. ***Test Equipment and Materials.*** Test equ required to adjust the dc offset is listed in table

Table 3-32 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 DC Offset Adjustment

Common name	Part/model no.	Qty	Manufact
Adapter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Test Probe	1986-36-R	1	Pomona
Test Lead, Banana Plug to Test Probe	1986-36-B	1	Pomona

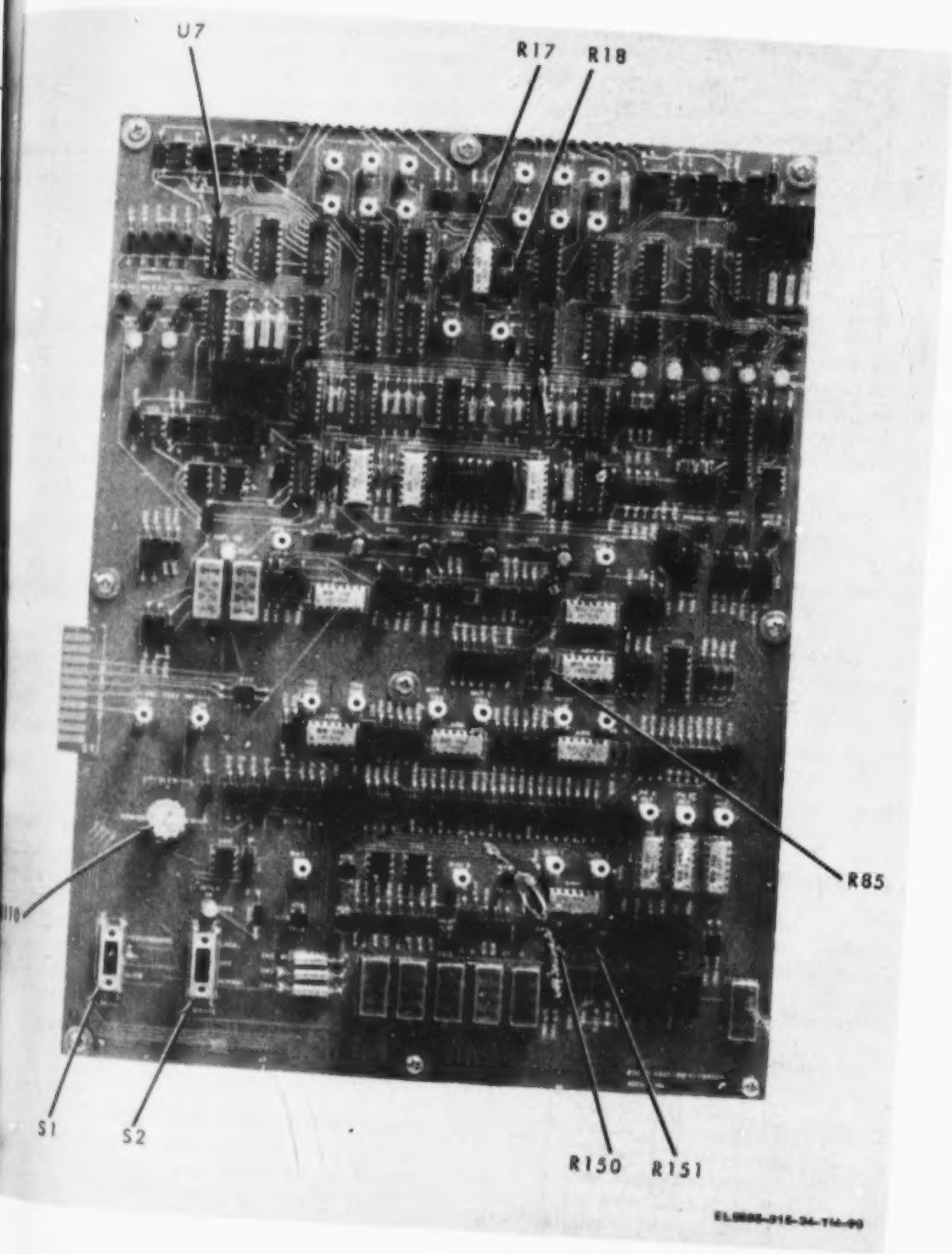

U7
R17
R18
R85
110
S1
S2
R150
R151
EL5895-915-34-TM-99

Figure 3-38. Electronic control amplifier HTA-9A2, 9A3 adjustments, component locations on circuit card assembly A1.

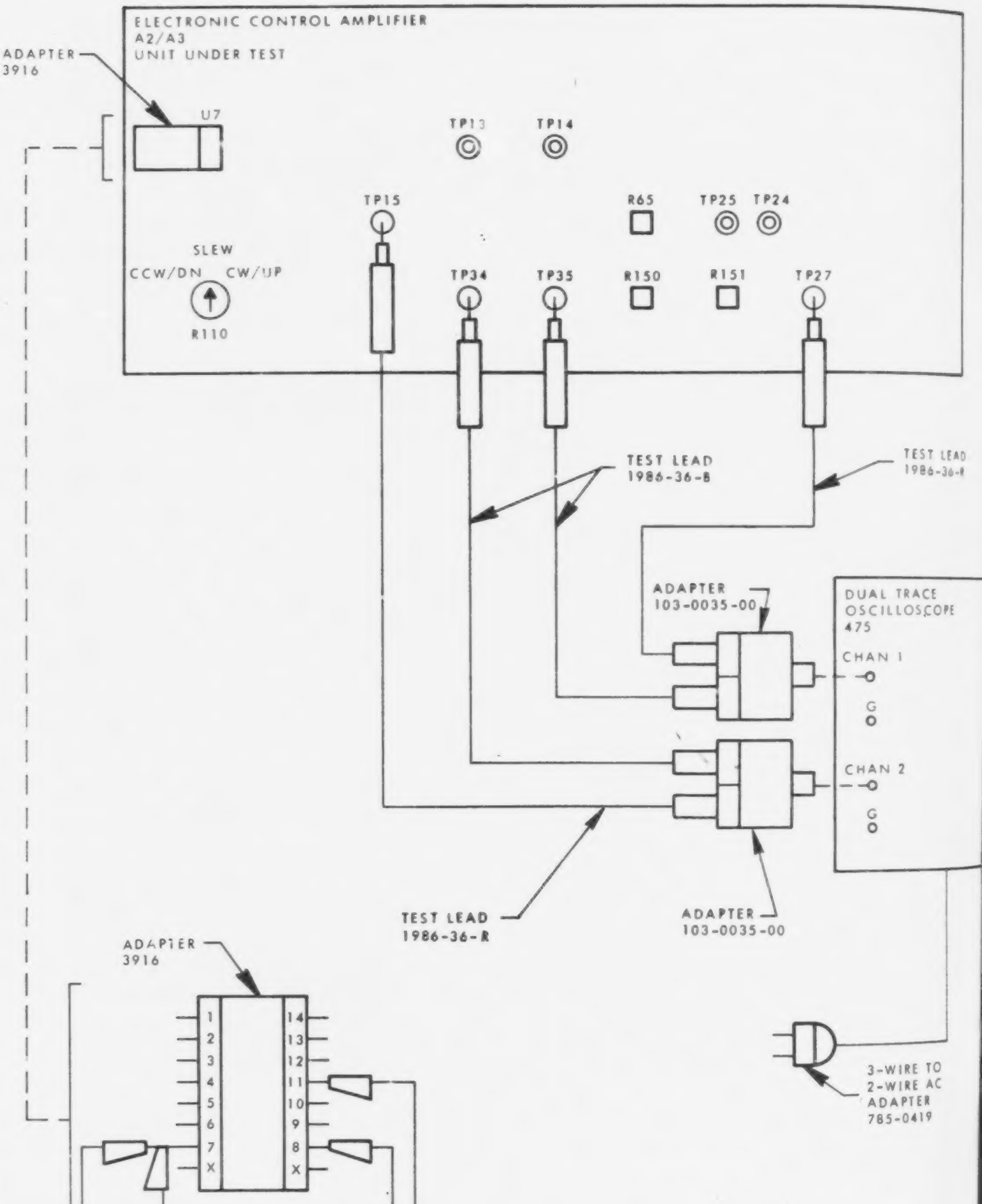

ELECTRONIC CONTROL AMPLIFIER
A2/A3
UNIT UNDER TEST
ADAPTER
3916
U7
TP13
TP14
TP15
R65
TP25
TP24
SLEW
CCW/DN
CW/UP
R110
TP34
TP35
R150
R151
TP27
TEST LEAD
1986-36-B
TEST LEAD
1986-36-
ADAPTER
103-0035-00
DUAL TRACE
OSCILLOSCOPE
475
CHAN 1
G
CHAN 2
G
TEST LEAD
1986-36-R
ADAPTER
103-0035-00
ADAPTER
3916
1
2
3
4
5
6
7
X
14
13
12
11
10
9
8
X
3-WIRE TO
2-WIRE AC
ADAPTER
785-0419
TEST LEADS
3781-12
EL5895-915-3

Figure 3-39. Electronic control amplifier HTA-9A2, 9A3 adjustments, test setup diagram

b. *Test Connections and Conditions.* Adjustment st point locations are shown on figure 3-17. Adjustment trols are shown on figure 3-38. Connect dual-trace illoscope channel 1 to circuit card assembly test points 14 and TP35. (See figure 3-39 for typical connec- s.)

c. *Initial Control Settings.* On circuit card assembly l, set OPERATE swich to LOCAL and LOCAL switch SLEW. On dual-trace oscilloscope, set controls as fol- ws.

Control	Position
VERT MODE	CH1
CH1 VOLTS/DIV	As required
CH1 AC-GND-DC slide control	DC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
INPUT COUPLING	DC
SOURCE	NORM
TIME/DIV	As required to observe display
A TRIGGER-SLOPE and LEVEL	As required for stable display
TRIGGER HOLD OFF	NORM
10x MAG	OFF (out)

d. *Adjustment Procedure.* Adjust for dc offset as ows:

(1) Connect CH1 and CH2 input of dual-trace oscilloscope to TP14 (MOT 2 CUR) and TP13 (MOT 1 CUR).

(2) Operate SLEW control to fully clockwise position and adjust AMP 2 TRIM R16 and AMP 1 TRIM R17 for oscilloscope indications of equal to or less than 2.5 V p-p.

(3) Return LOCAL switch to OFF and OPERATE switch to NORMAL.

. Cabinet-Mounted Components Removal and cement. Cabinet-mounted components include magnetic contactors K1 and K2, power-on flasher 1 and DS2, door interlock switch S1, cabinet fan B1, four power inductors L1 through L4. Refer to figure for parts location and identification. Prior to per- ing maintenance inside the cabinet, set circuit break- 3 (120/208 V ac), 21 (azimuth, 277/480 V ac) and (elevation, 277/480 V ac) on ac distribution box A-8A26 to OFF.

WARNING

CONTACTOR circuit breaker HTA-9A1CB2 controls application of the 277/480 V ac, 3-phase input to the scr assemblies. Do not perform any maintenance inside the cabinet with CONTACTOR circuit breaker CB2 set to ON.

WARNING

When performing maintenance on or around magnetic contactors HTA-9K1 or HTA-9K2, make certain that the ac input to applicable electronic control amplifier is turned off at ac distribution box HTA-8A26. 277/480 V ac, 3-phase power is otherwise present at magnetic contactor terminals.

WARNING

Use extreme care when performing maintenance inside the cabinet housing direct current control HTA-9 with the door interlock switch in the override position. Very high ac voltages (277/480 V ac) are present which could cause injury or death.

a. ***Magnetic Contactor K1, K2.*** Replace magnetic contactor K1 or K2 as follows.

(1) Remove four phillips-head screws, washers, and lockwashers that secure cover to magnetic contactor.

(2) Slide protective sleeves to expose terminals on magnetic contactor.

(3) Tag for identification, and disconnect all wires and cables from magnetic contactor.

(4) Remove two hex nuts, lockwashers, and flat washers from flange at bottom of contactor. Remove two phillips-head screws from outside the cabinet.

(5) Loosen hex nut at top of flange.

(6) Lift contactor with flange, up and out from cabinet side wall.

(7) Install replacement magnetic contactor in place with flange attachment holes aligned and secure contactor to cabinet side wall with in-place hex nut, lockwasher, and flat washer.

(8) Install two phillips-head screws from outside cabinet through contactor flange. Secure flange to cabinet with two hex nuts, lockwashers, and flat washers.

(9) Install sleeves on cables, then identify and connect wires and cables to contactor. Slide sleeves over terminals.

(10) Install cover on magnetic contactor and secure with four phillips-head screws, washers, and lockwashers.

(11) Set circuit breaker 13, 21, and 21 or 22 on ac distribution box to ON.

b. ***Power-On Flasher DS1, DS2.*** Replace power-on flasher DS1, DS2 as follows.

(1) Unsolder leads at rear of unit to be replaced.

(2) Press in on case-mounted spring-retaining clips to release unit from cabinet mounting bracket.

(3) Install replacement power on flasher into cabinet mounting bracket.

(4) Resolder wires at rear of unit.

c. ***Door Interlock Switch S1.*** Replace door interlock switch S1 as follows.

(1) Set 26 VDC EQPT circuit breaker on servo power supply assembly 14A9 to TRIPPED.

(2) Identify and remove the two wires from switch terminals.

(3) Remove two screws holding mounting bracket for flasher and interlock switch.

(4) Remove two screws holding interlock switch.

(5) Install replacement switch on mounting bracket.

(6) Reinstall mounting bracket to cabinet frame and secure with two phillips-head screws.

(7) Reconnect the two wires to interlock switch.

(8) Set 26 VDC EQPT circuit breaker on servo power supply assembly 14A9 to ON.

d. ***Cabinet Fan B1.*** Replace cabinet fan B1 as follows.

(1) Unsolder ac power lines from fan terminals.

(2) Remove 16 screws, washers, and lockwashers from cabinet exterior and remove rf filter.

(3) Remove eight hex nuts that secure fan to cabinet interior wall. Remove the eight screws from cabinet exterior. Lift fan up and out.

(4) Repair fan as follows.

- (a) Remove protective plastic cover on rotary hub to expose hub attachment screw.
- (b) Remove hub attachment screw and remove hub to expose two bolts that secure field coils and thermostat.
- (c) Replace field coil or thermostat as necessary.
- (d) Install hub on fan with hub attachment screw.
- (e) Place plastic cover on rotary hub and press down.

(5) Install fan in cabinet and secure with eight screws from cabinet exterior and hex nuts inside cabinet.

(6) Install rf filter on cabinet exterior with 16 screws washers and lockwashers.

(7) Solder wires to fan terminals.

e. ***Power Inductors L1 through L4.*** Each po
ductor weighs 400 pounds and requires a fork lift
table crane and wire rope to lift it. Power induc
and L2 are removed and replaced from the fron
cabinet, requiring removal of bottom cover panel;
L4 are removed and replaced from the rear of the c
In either case, electronic control amplifiers A3 and
must be removed to provide vertical clearance f
power inductors and lifting device. Each power in
has a lift-ring at each corner to facilitate handling
place any power inductor L1 through L4 as follow

WARNING

Do not attempt to remove any power inductor with power inputs connected Hazardous voltages (277/480 V ac and 240 V dc) are present inside the direct current control cabinet that houses the inductors.

WARNING

To prevent possible injury to personnel and damage to equipment, this procedure should be performed only by personnel familiar with handling heavy equipment

(1) Turn off all power to direct current
HTA9 as follows.

(a) On ac distribution box HTA-8A2
B (277/408 V ac, 3-phase, 4W,
CRITICAL), set circuit breakers CB21 and 22
(b) On ac distribution box, panel A (1
V ac, 3-phase, 4W, NON CRITICAL), set circuit
er CB13 to OFF.

(c) On stow pin control/minor fault
panel HTA-8A24, set power switch circuit brea
OFF.

(d) On servo power supply assembly 14
all circuit breakers to TRIPPED or down positio

(2) Remove electronic control amplifier A
A2 if necessary) as follows.

- (a) On electronic control amplifier cha
and disconnect six ac input wires at
and F6 on left side of panel and F7,
F9 on right side of panel (throu
door).
- (b) On scr assemblies A4 and A7, remo
washers, and lockwashers from
grey cable, dc output terminals
terminal lugs.
- (c) Tag for identification and remov
from R4 and R5 on electronic co
plifier panel by removing nut, was
lockwasher from each terminal.

(d) Remove hexhead bolts securing cables to K1 and K2 on electronic control amplifier panel and lift off terminal lugs.

(e) Remove self-locking nut securing grounds to electronic control amplifier panel on right side of panel and remove terminal lugs.

(f) Remove screws as necessary at front of panels to disconnect bars between A3 and A2 at center of panel to remove A3, or between A2 and A3, and A2 and A1, to remove A2.

(g) Remove bottom cover panel (if applicable) by removing four screws, washers, and lockwashers from front of cabinet.

(h) Tag and disconnect wires from terminal boards TB1 thru TB4 at front of panel.

NOTE

Step (*h*) above may be omitted, if feasible, to rest panel in swing-back arrangement.

(i) On electronic control amplifier front panel, remove eight screws, washers, and lockwashers while supporting unit and remove unit from cabinet.

(3) Slide protective sleeves on cables to expose terminal lugs on power inductors. Disconnect cables by removing hex nut, washers, lockwasher, and bolt from each terminal lug. Bend cables up and away from inductors.

(4) Remove four hex bolts, flat washers, and lockwashers that secure power inductor to base of cabinet.

(5) String wire ropes through lift rings and attach wire ropes to lifting arm of fork lift or portable crane.

(6) Lift power inductor straight up to clear cabinet frame then swing out from cabinet.

(7) Determine correct orientation of replacement power inductor and accordingly string wire rope through lift rings.

(8) Attach wire ropes to lifting arm of fork lift or portable crane.

(9) Lift power inductor to clear cabinet frame, position over mounting holes, and carefully lower to rest position.

(10) Attach power inductor to cabinet base with four hex bolts, washers, and lockwashers.

(11) Install sleeves on cables, then install terminal lugs on power inductor terminals with bolt, two washers, lockwasher, and nut. Slide protective sleeves over terminals.

(12) Replace electronic control amplifier(s) as follows.

(a) Install electronic control amplifier in place on cabinet and attach with eight lockwashers, washers, and screws.

(b) Install screws as necessary at front of panels to connect bars between A3 and A2 at center of panels to replace A3, or between A2 and A3, and A2 and A1, to replace A2.

(c) Identify wires and connect to terminal boards TB1 through TB4 at front of panel, if applicable.

(d) Install bottom cover panel on cabinet (if applicable) with four screws, washers, and lockwashers.

(e) Connect grounds to electronic control amplifier panel ground lugs on right side of panel with self-locking nut.

(f) Install terminal lugs on A2 (or A3) panel K1 and K2 terminals with hex head bolt.

(g) Identify and install R4 and R5 cable terminals on electronic control amplifiers with nut, washer, and lockwasher for each terminal.

(h) Install terminal lugs on dc output terminals on scr assemblies A4 and A7 (red cable to terminal nearest panel). Secure with hex nuts, washers, and lockwashers.

(i) On electronic control amplifier chassis, identify and attach ac input wires to fuse terminals with lockwashers and nuts.

Section XVI. MAINTENANCE OF ANTENNA ANCILLARY GROUP HTA-12

eneral. Maintenance of antenna ancillary TA-12 consists of removal and replacement of mponents of antenna drive assemblies A1 A4, electric disk brake friction disks, and motor Major components to be replaced are dc tachom- otor blower B2. For replacement of dc drive , refer to higher level maintenance.

3-100. Tachometer-Generator G1 Removal and Replacement (fig. 3-30). The replacement procedure below covers both the azimuth and elevation dc tachometer-generator. See figure 3-30 for parts location and identification.

CAUTION

When performing the removal and replacement procedure, adequate support must be provided for the body of the dc tachometer-generator to prevent coupling damage. The tachometer weighs approx 35 pounds.

WARNING

Antenna drive assembly power must be turned off prior to performing maintenance on the dc tachometer-generator to prevent serious injury or death from contact with 120/208 V ac.

a. Set CB17 on ac distribution box HTA-8A26 panel A to OFF.

b. Remove 12 bolts and flat washers securing the three access covers to tachometer adapter housing.

c. Remove six screws securing electrical access cover to dc tachometer-generator and remove cover and gasket.

d. Remove cover and gasket from L-connector and T-connector nearest flexible conduit.

e. Tag and disconnect electrical wires in electrical access.

f. Pull wires through conduit to T-connector. Detach flexible conduit at L-connector.

g. Loosen two allen head setscrews securing dc tachometer-generator shaft to flexible coupling.

h. Remove four mounting bolts through access openings in adapter housing while supporting dc tachometer-generator and remove dc tachometer-generator and attached conduit.

i. Disconnect conduit from dc tachometer-generator.

j. Position replacement dc tachometer-generator shaft into flexible coupling.

k. Support dc tachometer-generator in position and replace four mounting bolts through adapter housing access opening; tighten set screws connecting flexible coupling to tachometer shaft.

l. Install rigid conduit and L-connector to dc tachometer-generator housing.

m. Install flexible conduit to L-connector.

n. Thread cables through conduit and L-connector into dc tachometer-generator.

o. Identify and connect the electrical wires.

p. Install gasket and cover on the L- and T- connectors.

q. Install electrical access cover on dc tachome generator with six screws.

r. Install three access covers on adapter housing a secure with 12 bolts and flat washers.

s. Set CB17 on ac distribution box HTA-8A26 pa A to ON.

t. Perform antenna drive assembly performance (section XXXIII).

3-101. Electric Disk Brake A1 Removal and Rep cement/Repair (fig 3-30). When higher level main nance is indicated, the dc tachometer-generator a adapter must be disconnected from the electric d brake; then the electric disk brake upper housing asse bly must be removed from the dc drive motor, reasse bled, and submitted to higher level maintenance. Rep of an electric disk brake consists of replacement of fri tion disks and involves removing the dc tachome generator/adapter/electric disk brake lower housing a sembly (fig 3-30) to gain access to braking compon (See figure 3-41). To replace an electric disk brake, pe form steps a and b below. To replace friction disks, pe form step c below. These procedures apply to either azimuth or elevation electric disk brake; however, supp requirements will be different.

CAUTION

When performing the electric disk brake removal and replacement procedure, adequate support must be provided to prevent injury to personnel or damage to the coupling. The tachometer/lower brake assembly weighs in excess of 50 pounds.

WARNING

Antenna drive assembly power must be turned off prior to performing maintenance involving the dc tachometer-generator or electric disk brake to prevent serious injury or death from contact with 120/208 V ac.

a. ***Electric Disk Brake Removal (fig. 3-30 and 3-*** To remove an electric disk brake, perform the steps scribed below.

(1) Manually release brakes with brake re lever.

(2) Provide personnel or equipment suppor electric disk brake.

(3) Remove six screws securing electrical a cover to dc tachometer-generator and rem cover and gasket (fig. 3-30).

(4) Remove cover and gasket from L-conn and T-connector nearest flexible condui

(5) Tag and disconnect electrical wires in electrical access.

(6) Pull wires through conduit to lower T-connector. Detach flexible conduit at L-connector.

(7) Remove four brake housing bolts and remove tachometer/adapter/brake lower housing assembly from upper brake housing assembly.

(8) Remove 12 bolts and washers securing three access covers to tachometer adapter housing.

(9) Loosen two setscrews holding flexible coupling to tachometer shaft inside the adapter (fig. 3-40).

(10) Remove four socket-head screws securing adapter housing to brake housing.

(11) Remove hex bolt securing flexible coupling to shaft extension.

(12) Tag and remove wires to relay and microswitches on brake electrical assembly.

(13) Tie back brake release solenoid with wire or string to keep brakes released and to relieve pressure on braking assembly.

CAUTION

When the braking and brake electrical assemblies are released, six small springs and three washers will be dispersed. Retain these items for reassembly.

(14) Remove three screws that secure braking and brake electrical assemblies to upper brake housing and remove assembly from hub to expose end plate retaining bolts.

(15) Remove conduit and T-connector assembly from upper brake housing as follows.

  (a) Remove two screws securing cover to remaining T-connector and remove cover.

  (b) Pull wires from upper brake housing assembly through T-connector. Pull wires from conduit and T- connector assembly.

  (c) Remove T-connections at flexible conduit from both junction boxes and pull wires clear of conduit and T- connector assembly.

  (d) Remove conduit and T-connector assembly (with short nipple) at entrance to upper brake housing.

(16) Remove four bolts that secure upper brake housing to dc drive motor housing and remove upper brake housing.

(17) Reassemble braking assembly and brake electrical assembly with three screws.

(18) Reassemble brake housing assemblies with four housing bolts and submit electric disk brake to higher level maintenance.

b. Electric Disk Brake Replacement (fig. 3-30 and 3-40). To replace an electric disk brake, perform the steps described below.

(1) Turn manual release lever on repaired or replacement electric disk brake to 90-degree position with respect to brake axis to release brake.

(2) Remove four housing bolts and disassemble housing assemblies, braking assembly, and brake electrical assembly.

(3) Tie back brake release solenoid with wire or string to keep brakes released and to relieve pressure on braking assembly.

(4) Mount upper brake housing to dc drive motor housing with four bolts.

(5) Install conduit and T-connector assembly on upper brake housing as follows.

  (a) Remove screw plug and install rigid conduit (short nipple) in upper brake housing.

  (b) Install conduit and T-connector assembly on short nipple.

  (c) Thread the two wires from TB1/TB2 junction box through upper T-connection and into upper brake housing assembly.

  (d) Thread the six wires from TB3/TB4 junction box through lower T-connection.

  (e) Connect lower T-connector to flexible conduit from TB3/TB4 junction box.

  (f) Thread four shorter wires from lower T-connector through upper T-connection and into upper brake housing assembly.

  (g) Thread the two long wires from lower T-connections through flexible coupling.

(6) Thread wires through hole in brake electrical assembly and install braking assembly and brake electrical assembly on hub as shown on figure 3-40. Secure with three screws.

(7) Identify and connect wires to relay and microswitch terminals on brake electrical assembly. Remove solenoid tie.

(8) Install key in shaft extension keyway in lower brake housing. Align key with keyway in hub and install lower brake housing on upper brake housing. Secure with four housing bolts.

(9) Install flexible coupling on shaft extension with hex bolt and lockwasher.

(10) Install dc tachometer-generator/adapter assembly on flexible shaft and secure to brake housing with four socket head screws.

(11) Attach flexible coupling to tachometer shaft with two setscrews in flexible coupling inside the adapter.

(12) Install the three access covers on adapter housing with twelve bolts and washers.

(13) Connect flexible conduit to L-connector.

(14) Thread wires through L-connector and conduit into dc tachometer-generator from lower T-connector.
(15) Identify and connect wires to dc tachometer-generator terminals in electrical access.
(16) Install electrical access cover and gasket with six screws.
(17) Install covers on L- and T-connectors and secure with two screws.
(18) Set brakes with brake release lever.

c. Friction Disk Replacement (fig. 3-30 and 3-40). To replace worn friction disks in an electric disk brake, perform the following.

(1) Perform steps (1) through (7) and (12) through (14) of paragraph 3-101*a* above.
(2) Remove brake electrical assembly, pressure plate stationary disk, and two friction disks from hub. Replace disks.
(3) Perform steps (6) through (8) and (13) through (18) of paragraph 3-101*b* above.

3-102. Motor Blower B2 Removal and Replacement (fig. 3-30). The following procedures cover both azimuth and elevation motor blowers. To remove a motor blower, perform the following steps. See figure 3-30 for parts location and identification.

CAUTION

When performing removal and replacement procedure, adequate support must be provided for motor blower. The motor weighs approximately 33 pounds.

WARNING

Antenna drive assembly power must be turned off prior to replacing the motor blower to prevent serious injury or death from contact with 120/208 V ac.

a. Provide personnel or equipment support for motor blower B2.
b. Remove four screws and lockwashers securing access panel to motor blower housing and remove panel and gasket.
c. Note the coding and connections; identify and then disconnect the three leads to motor blower.
d. Disconnect conduit from motor blower housing.
e. Remove four hex bolts that secure motor blower housing to drive motor.
f. Remove five bolts that secure two parts of blower chamber.
g. Using allen head wrench, remove set screw that secures squirrel cage blower to motor shaft and remove squirrel cage and key from motor
Retain key for reassembly.
h. Remove four screws that secure blower
to motor.
i. Attach blower chamber to replacement
with four screws.
j. Install squirrel cage blower on replacement
blower shaft and install key.
k. Tighten set screws to secure blower to motor
er shaft.
l. Secure upper motor blower housing to the
housing with five mounting bolts.
m. Support motor blower assembly and
drive motor with four mounting bolts.
n. Thread conduit leads into blower motor and
conduit to motor.
o. Connect the three leads from motor to the
leads.
p. Install panel and gasket on motor blower
and secure with four screws and lockwashe

**3-103. DC Tachometer-Generator Brushes
cement (fig. 3-30).**

To replace brushes in a dc tachometer-generat
move two screws securing each access cover plate,
plug and lift brush assembly from cavity, inser
brush, install plug, and install access cover plate

**3-104. DC Drive Motor Brush Replacement
30).** Each dc drive motor contains four dual br
semblies behind access plates. To replace any br
sembly, manually release the brakes, then comple
steps described below.

a. Remove four hex head bolts and washers th
cure access plate to dc drive motor and
plate.
b. Loosen screw securing pigtail to brush
Disconnect spade lug contact.
c. Push spring in and toward opposite side of
holder to disengage lock tab.
d. Lift spring out and remove brush assembly
e. Place new brush in holder with bevel
spring. Brush should move freely in holder
f. Push spring in until lock tab engages spri
g. Insert pigtail spade lug contact under scre
tighten screw to secure pigtail to brush
h. Fit brush to commutator radius as follows
  (1) Apply a strip of coarse sandpaper to th
  tour of commutator. Do not use emery
  (2) Apply pressure to brush with scre
  while turning commutator by hand.
  (3) Remove sandpaper from commutator.
i. Install access plate with four hex head

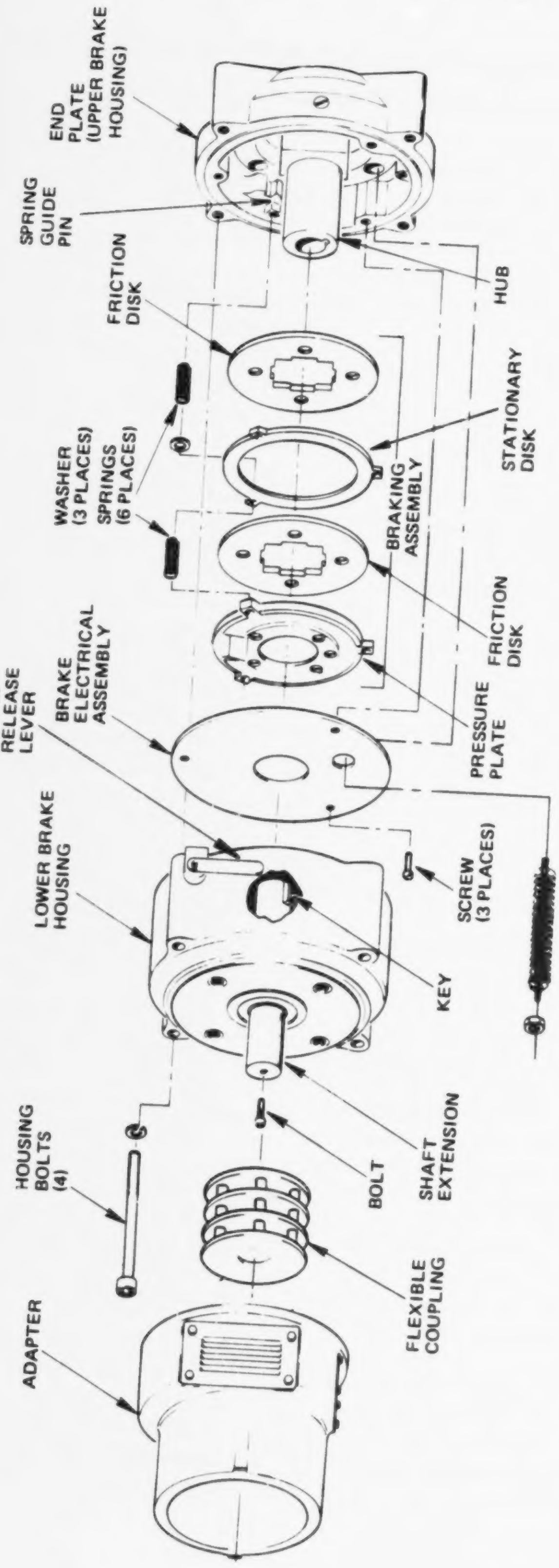

ADAPTER
FLEXIBLE COUPLING
HOUSING BOLTS (4)
BOLT
SHAFT EXTENSION
LOWER BRAKE HOUSING
KEY
MANUAL BRAKE RELEASE LEVER
SCREW (3 PLACES)
BRAKE ELECTRICAL ASSEMBLY
PRESSURE PLATE
FRICTION DISK
BRAKING ASSEMBLY
STATIONARY DISK
WASHER (3 PLACES)
SPRINGS (6 PLACES)
FRICTION DISK
HUB
SPRING GUIDE PIN
END PLATE (UPPER BRAKE HOUSING)
EL5895-915-34-TM-98

Figure 3-40. Electric disk brake HTA-12A1A1,12A2A1, 12A3A1,12A4A1, exploded view.

SECTION XVII. MAINTENANCE OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 and HTA-6A6A1

3-105. General. This section provides instructions for replacing assemblies, subassemblies, and modules of azimuth data module HTA-8A7A1 and elevation data module HTA-6A6A1. Adjustment procedures are provided for the synchros and limit switches in either data module. (See figure 3-32 for typical data module parts location and identification.)

NOTE

> A roll pin such as MS16562-220 is required to load antibacklash gears in the following procedures.

3-106. Synchro B2 Removal and Replacement (fig. 3-32). To replace synchro B2 in either the azimuth or elevation data module, perform the steps described below.

WARNING

> Do not allow antenna to be moved while a synchro is removed. Loose cables and yoke movement without positional reference could cause injury.

CAUTION

> Do not allow antenna to be moved while a synchro is removed from the assembly. A slight antenna movement with positional reference disconnected would require a complete realignment of the antenna.

a. Position antenna to 000.00 degree elevation or 180.00 degrees azimuth as indicated on antenna control panel 14A8 AZIMUTH or ELEVATION position indicator; then set key switch on antenna position and status panel 14A7 to safe condition (ANT SAFE indicator illuminated) and remove key to prevent antenna movement while a synchro is removed or electrically disconnected.

b. Press MAINT indicator switch on antenna position and status panel 14A7 to maintenance mode.

c. Set SYNCHRO REF 120 VAC circuit breaker on servo power supply assembly 14A9 to off (down) position.

d. Turn off dry air pressure to data module by turning pressure supply handwheel (located on or near data module) fully clockwise.

e. Loosen 12 captive screws and remove cover.

f. Tag and remove five wires from synchro.

g. Remove both side covers and gaskets by rem
10 screws and seal washers in each cover.

h. Install roll pin in B2 antibacklash gear ass
preload holes.

i. Loosen three captive screws securing syn
clamp to housing and remove clamp from syn

j. Carefully remove synchro and attached gea
sembly straight out through housing.

k. Loosen hub clamp screw and remove gear as
bly from synchro shaft. Retain gear assembly
reuse.

l. Loosely install gear assembly on replacement
chro shaft. Align gear flush with end of shaft
tighten hub clamp screw.

m. Turn gear assembly so that index mark on
end is aligned with arrow on synchro body. In
synchro and gear assembly through hole in
ing, then carefully mesh B2 antibacklash
with B2, B3, and S1 spur gear.

n. Install synchro clamp on synchro body with
sides mated to adjacent clamps, then inser
three captive screws in housing.

o. Tighten all three captive screws finger tigh
check synchro for proper seating and gear
proper mesh.

NOTE

> The gears are properly meshed when the spur gear completely engages the antibacklash gear.

p. Rotate synchro body so that mark on sy
body exactly aligns with mark on end of sy
shaft.

q. Using care not to move synchro, tighten the
synchro clamp screws.

r. Remove roll pin from antibacklash gears.

s. Connect five wires to synchro.

t. Set SYNCHRO REF circuit breaker on
power supply assembly 14A9 to ON.

u. Perform fine synchro electrical alignment
3-110).

v. Tighten the three screws in synchro B3
finger tight (if applicable).

w. Install cover with 12 captive screws and
screws finger tight.

x. Install side cover and gasket with 10 seal w
and self-locking screws.

y. Turn on dry air pressure with handwheel located on or near data module.

-107. Synchro B1 or B3 Removal and Replace- nt (fig. 3-32). To replace synchro B1 or B3 in either azimuth or elevation data module, perform the steps scribed below.

WARNING

Do not allow antenna to be moved while a synchro is removed. Loose cables and yoke movement without positional reference could cause injury.

CAUTION

Do not allow antenna to be moved while a synchro is removed from the assembly. A slight antenna movement with positional reference disconnected would require a complete realignment of the antenna.

a. Position antenna to 000.00 degrees elevation or 180.00 degrees azimuth as indicated on antenna control panel 14A8 AZIMUTH or ELEVATION position indicator; then set key switch on antenna position and status panel 14A7 to safe condition (ANT SAFE indicator illuminates) and remove key to prevent antenna movement while a synchro is removed or electrically disconnected.

b. Set SYNCHRO REF 120 VAC circuit breaker on servo power supply assembly 14A9 to off (down) position.

c. Turn off dry air pressure to data module by turning pressure supply handwheel fully clockwise.

d. Loosen 12 captive screws and remove cover.

e. Tag and remove five wires from synchro.

f. Remove both side covers and gaskets by removing 10 screws and seal washers in each cover.

g. Install roll pin in antibacklash gear assembly preload holes.

Loosen three captive screws securing synchro clamp to housing and remove clamp from synchro.

Carefully remove synchro and attached gear assembly straight out through housing.

Loosen hub clamp screw and remove gear assembly from synchro shaft. Retain gear assembly for reuse.

Loosely install gear assembly on replacement synchro shaft. Align gear flush with end of shaft and tighten hub clamp screw.

Turn gear assembly so that index mark on shaft end is aligned 180 degrees from arrow on synchro body, insert synchro and gear assembly through hole in housing, then carefully mesh synchro gear with the antibacklash gear.

m. Install synchro clamp on synchro body with flat sides mated to adjacent clamps, then insert the three captive screws in housing.

n. Tighten all three captive screws finger tight and check synchro for proper seating and gears for proper mesh.

NOTE

The gears are properly meshed when the spur gear completely engages the antibacklash gears.

o. Rotate synchro body so that mark on synchro body is aligned exactly 180 degrees from mark on end of synchro shaft.

p. Using care not to move synchro, tighten the three synchro clamp screws.

q. Remove roll pin from antibacklash gears.

r. Connect five wires to synchro.

s. Set SYNCHRO REF circuit breaker on servo power supply assembly 14A9 to ON.

t. Perform fine synchro electrical alignment for synchro B1 or B3 (para 3-110).

u. Tighten the three screws in synchro clamp hand tight (if applicable).

v. Install cover with 12 captive screws and tighten screws hand tight.

w. Install side cover and gasket with 10 seal washers and self-locking screws.

x. Turn on dry air pressure with handwheel located near data module.

3-108. Limit Switch S1 Removal and Replacement (fig. 3-32). To replace limit switch S1 in either the azimuth or elevation data module, perform the steps described below.

WARNING

Up to 105 volts ac is present in the data module, between synchro contacts. Use caution when performing maintenance inside the unit.

a. Set 26 V dc circuit breaker on servo power supply assembly 14A9 to TRIPPED.

b. Turn off dry air pressure to data module by turning pressure supply handwheel fully clockwise.

c. Loosen 12 captive screws and remove cover.

d. Remove both side covers and gaskets by removing 10 screws and seal washers in each cover.

e. Tag and disconnect wires from limit switch.

f. Loosen three panhead screws, rim-clenching clamps, and washers.

g. Loosen setscrew in antibacklash gear hub clamp and pull limit switch and shaft extension straight out while supporting gear. The clamp, located on base of switch, must be removed with switch; if removal of clamp is difficult, perform the steps described below and then proceed to step *i*.

(1) Loosen hub clamp on extension shaft.

(2) Pull limit switch out of extension shaft while supporting gear and extension shaft, leaving switch clamp mounted.

(3) Remove extension shaft from antibacklash gear.

(4) Loosen switch clamp and remove from housing.

h. Remove extension shaft from antibacklash gear.

i. Butt shaft extension to end of replacement limit switch shaft and tighten setscrew in clamp.

j. Align holes in backlash gear halves and insert roll pin.

k. Insert limit switch through housing and S1 antibacklash gear assembly.

l. Align cleats over limit switch flange and tighten setscrews finger tight.

m. Turn limit switch until adjustment screws are accessible.

n. Align S1 antibacklash gear to mate with B2, B3, and S1 spur gear, then tighten setscrew in clamp.

o. Mesh antibacklash gear with spur gear, remove roll pin, and tighten clamp.

p. Install wires on limit switch segments.

q. Align limit switch (paragraph 3-111 for elevation limit switch, paragraph 3-112 for azimuth limit switch).

r. Install cover with 12 captive screws.

s. Install side cover and gasket with 10 seal washers and self-locking screws.

t. Turn on dry air pressure with handwheel located near data module.

u. Set 26 V dc circuit breaker on servo power supply assembly 14A9 to ON.

3-109. Coarse Synchro Zeroing Procedure. All three synchros in either the azimuth or elevation data module must be coarse aligned (zeroed) when a replacement synchro has been installed or when an off-alignment condition has been noted in the respective data module. The procedures described below apply to both data modules.

a. Test Equipment. No special test equipment is required to zero-adjust the synchros.

b. Test Connections and Conditions. The co synchro zeroing procedure requires that the data mod be connected in a normal operational configuratio follows. Verify that the servo power is turned on (ref TM 11-5895-898-12 or TM 11-5895-899-12), that stow pins are retracted (STOW indicator on antenna sition and status panel 14A7 extinguished) in accord with procedures in TM 11-5895-898-12 or TM 11-5 899-12, and that the antenna is positioned to 0 de elevation (or 180 degrees azimuth). A minimum of persons is required to perform the procedure. One pe is required to monitor antenna control panel 14A8 antenna position and status panel 14A7 indicators, other person is required to perform specified operat and observations at the data module. Telephones are c veniently located for operator communications. Set c trols on servo and control equipment as follows.

(1) Press MAINT switch-indicator on ant position and status panel 14A7 to mai nance mode (MAINT indicator lighted).

(2) Set operate switch S2 on direct current c trol HTA-9 to NORMAL.

(3) Rotate antenna safe key switch on ant position and status panel 14A7 clockwise observe that all lights on the antenna pos and status panel (except MAINT) go out not, refer to appropriate procedure for recting fault or limit condition. If STATUS indicators remain lit, check ant safety interlock circuits for an open swi

c. Initial Test Equipment Settings. This adjustm procedure does not require the use of any test equipm

d. Adjustment Procedure. Perform the adjustm as follows.

(1) Loosen three set screws at base of sync

(2) For elevation synchro B1, B2, or B3, or imuth synchro B2, turn synchro shaft index mark on shaft is visually aligned arrow on synchro body; for azimuth syn B1 or B3, turn synchro shaft until index on shaft and arrow on synchro body are o site.

(3) Tighten the three setscrews.

3-110. Fine Synchro Electrical Alignme Perform the operations described below after a rep ment synchro has been coarse aligned and prior to pl the antenna in an operational mode.

a. Test Equipment. A vom 260-6 with test pro required to monitor synchro stator outputs.

b. Test Connections and Conditions. The fine chro electrical alignment requires that the data mo be connected in a normal operational configuration servo power turned on, stow pins retracted, and an positioned to 0 degree elevation (or 180 degrees azi A minimum of two persons is required to perform edure. One person is required to monitor antenna rol panel 14A8 and antenna position and status panel 7 indicators; the other person is required to perform ified operations and observations at the data module. phones are conveniently located for operator communications.

c. ***Initial Control Settings.***

(1) Press MAINT switch-indicator on antenna position and status panel 14A7 to maintenance mode (MAINT indicator lit).

(2) Rotate antenna safe key switch on antenna position and status panel 14A7 clockwise and observe that all lights on antenna position and status panel (except MAINT) go out. If not, refer to appropriate procedure for correcting fault or limit condition. If all STATUS indicators remain lit, check antenna safety interlock circuits for an open switch.

(3) Set vom function switch to AC.

d. ***Alignment Procedure.*** Perform the alignment edure as follows.

(1) Connect vom leads to synchro B1 stator windings S1 and S3.

(2) Loosen three setscrews at base of synchro and adjust stator housing for null point.

(3) Repeat step 2 above as necessary to obtain minimum null point.

(4) Tighten setscrews.

(5) Disconnect vom from synchro B1 and connect to synchro B2 stator windings S1 and S3. Repeat steps (2) through (4).

(6) Disconnect vom from synchro B2 and connect to synchro B3 stator windings S1 and S3. Repeat steps (2) through (4).

(7) Confirm zero reference indication on applicable position indicator.

. Elevation Data Module Limit Switch S1 ment. The procedures described below provide ent of the limit switch in the elevation data mod-

Test Equipment. A vom 260-6 with test leads is ed to monitor limit switch dc voltages.

Test Connections and Conditions. The elevation odule limit switch alignment requires that the data le be connected in a normal operational configura- ith servo power turned on and stow pins retracted. imum of two persons is required to perform the dure. One person is required to monitor antenna l panel 14A8 and antenna position and status panel indicators; the other person is required to perform ed operations and observations at the data module. ones are conveniently located for operator com- ations. In the procedures described below, use the T indicator switch on the antenna position and panel to provide positive control of the antenna to t accidental movement during adjustment.

c. ***Initial Control Settings.***

(1) Rotate antenna safe key switch on antenna position and status panel 14A7 clockwise and observe that all lights on antenna position and status panel (except MAINT) go out. If not, refer to appropriate procedure for correcting fault or limit condition. If all STATUS indicators remain lit, check antenna safety interlock circuits for an open switch.

(2) Set vom function switch to +DC and range switch to 50V.

d. ***Alignment Procedure.*** Perform the alignment procedure as follows.

WARNING

Elevation data module limit switch alignment requires that the antenna be moved about the elevation axis. Additionally, the transmitter down limiting function is unreliable when the limit switch is being aligned. Extremely hazardous conditions from rf radiation exist if the low elevation cutoff limit switch segment (E) is not functioning properly. Before commencing the alignment, advise appropriate personnel, so they may take the necessary precautions.

CAUTION

The limit switch alignment procedure requires that the antenna be operated into the electrical limits. When operating near the servo and electrical limits, it may be necessary to jumper the terminals of switch segments A through D to permit use of servo controls for moving the antenna. If necessary, the antenna handcranks on the elevation gear boxes may be used for antenna positioning. To prevent engaging the structural limits of the antenna, use extreme care when driving the antenna with the SLEW control or antenna control panel handcrank.

NOTE

The antenna positions specified in the alignment procedure are typical, based on the established limits given below. Site specifications should be checked for comparison and if the limits are other than those shown below, appropriate allowances should be made.

	Degrees (nominal)
Servo limit-up	91.0
Electrical limit-up	92.0
Electrical limit-down	-2.0
Servo limit-down	-0.5
Transmitter down-limit	7.5

(1) ***Servo limit-up alignment.***

(a) Position antenna to 91 degrees as indicated on antenna control panel 14A8 ELEVATION position indicator. Jumper the terminals of switch segments A through D if necessary to permit use of servo controls for moving antenna.

(b) Remove any jumpers installed in (a) above and connect vom across segment NC (+) and C terminals.

(c) Adjust screws A and B on segment C so that contacts just open at 91 ±0.1 degrees and close at 90.5 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(d) If contacts cannot be set as specified in step (*c*), repeat steps (*a*) through (*c*) above, except use opposite adjustment screw in step (*c*).

(e) Tighten locking screws. Observing caution, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching antenna to exact limit point, then retightening adjustment and locking screws. Disconnect vom.

(2) ***Electrical limit-up alignment.***

(a) Position antenna to 92 degrees as indicated on antenna control panel 14A8 ELEVATION position indicator. Jumper the terminals of switch segments A through
necessary to permit use of servo
for moving antenna.

(b) Remove any jumpers installed in ste
above and connect vom across segme
NC (+) and C terminals.

(c) Adjust screws A and B on segment
that contacts just open at 92 ±0.1
and close at 91.6 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require making several attempts to obtain specified limits.

(d) If contacts cannot be set as specified
(*c*), repeat steps (*a*) through (*c*) abo
cept use opposite adjustment screw
(*c*).

(e) Tighten locking screws. Observing
move antenna to original limit to
setting. Make small adjustments
essary by loosening appropriate
and adjustment screws, inching
exact limit point, then retighten
ment and locking screws. Disconne

(3) ***Electrical limit-down alignment.***

(a) Position antenna to -2 degrees (358
tion on antenna control panel 14A
VATION position indicator). Jum
terminals of switch segments A thr
if necessary to permit use of servo
for moving antenna.

(b) Remove any jumpers installed in
above and connect vom across se
NC (+) and C terminals.

(c) Adjust screws A and B on segm
that contacts just open at -2 ±0.1
and close at -1.6 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(*d*) If the contacts cannot be set as specified in step (c), repeat steps (a) through (c) above, except use opposite adjustment screw in step (c).

(*e*) Tighten locking screws. Observing caution, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching antenna to exact limit point, then retightening adjustment and locking screws. Disconnect vom.

(4) ***Servo limit-down alignment.***

(*a*) Position antenna to -0.5 degrees (359.5 degrees as indicated on antenna control panel 14A8 ELEVATION position indicator). Jumper the terminals of switch segments A through D if necessary to permit use of servo controls for moving the antenna.

(*b*) Remove any jumpers installed in step (*a*) above and connect vom across segment D NC (+) and C terminals.

(*c*) Adjust screws A and B on segment D so that contacts just open at -0.5 ±0.1 degrees and close at -0.1 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(d) If the contacts cannot be set as specified in step (*c*), repeat steps (*a*) through (*c*) above, except use opposite adjustment screw in step (c) to effect contact opening.

(e) Tighten locking screws. Observing caution, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching antenna to exact limit point, then retightening adjustment and locking screws. Disconnect vom.

(5) ***Transmitter down-limit alignment.***

(a) Position antenna to 7.2 degrees (or designated transmitter down-limit) as indicated on antenna control panel 14A8 ELEVATION position indicator. Jumper the terminals of switch segments A through D if necessary to permit use of servo controls for moving antenna.

(b) Remove any jumpers installed in (a) above and connect vom across segment E NC (+) and C terminals.

(c) Adjust screws A and B on segment E so that contacts just open at 7.2 ±0.1 degrees and close at 7.6 ±0.1 degrees.

NOTE

An open contact is indicated by -10 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain the specified limits.

(d) If the contacts cannot be set as specified in step (*c*), repeat steps (*a*) through (*c*) above, except use opposite adjustment screw in step (*c*).

(e) Tighten locking screws. Observing caution, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching antenna to exact limit point, then retightening adjustment and locking screws. Disconnect vom.

3-112. Azimuth Data Module Limit Switch S1 Alignment. The procedures described below provide alignment for the limit switch in the azimuth data module.

a. Test Equipment. A vom 260-6 with test leads is required to monitor the limit switch dc voltages.

b. Test Connections and Conditions. The azimuth data module limit switch alignment requires that the data module be connected in a normal operational configuration, with servo power turned on and stow pins retracted. A minimum of two persons is required to perform the procedure. One person is required to monitor antenna control panel 14A8 and antenna position and status panel 14A7 indicators; the other person is required to perform specified operations and observations at the data module. Telephones are conveniently located for operator communications. In the following procedures, use the MAINT indicator switch on the antenna position and status panel to provide positive control of the antenna to prevent accidental movement during adjustment.

c. Initial Test Equipment Settings.

(1) Rotate antenna safe key switch on antenna position and status panel 14A7 clockwise and observe that all lights on antenna position and status panel (except MAINT) go out. If not, refer to appropriate procedure for correcting fault or limit condition. If all STATUS indicators remain lit, check antenna safety interlock circuits for an open switch.

(2) Set vom function switch to +DC and range switch to 50V.

d. Alignment Procedure. Perform the alignment procedure as follows.

CAUTION

The limit switch alignment procedure requires that the antenna be operated into the electrical limits. When operating near the servo and electrical limits, it may be necessary to jumper the terminals of switch segments A through D to permit use of servo controls for moving the antenna. If necessary, antenna handcranks on azimuth gear boxes may be used for antenna positioning. Use extreme care when driving the antenna with the SLEW control or antenna control panel hand crank to prevent engaging cable wrap wrap and structural limits of the antenna.

NOTE

The antenna positions specified in the alignment procedure are typical, based on the following established limits. Site specifications should be checked for comparison and if the limits are other than those shown below, appropriate allowances should be made.

	Degrees (nominal)
Servo limit-cw	345
Electrical limit-cw	350
Electrical limit-ccw	10
Servo limit-ccw	15

(1) ***Servo limit-clockwise alignment.***

(a) Position antenna to 345 degrees as cated on antenna control panel 14A IMUTH position indicator. Jumper terminals of switch segments A throu if necessary to permit use of servo con for moving antenna.

(b) Remove any jumpers installed in step above and connect vom across segme terminals.

(c) Adjust screws A and B on segment that contacts just open at 345 ±0.1 de and close at 344.6 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

In the following steps, when making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(d) If contacts cannot be set as specified (c), repeat steps (*a*) through (*c*) abo cept use opposite adjustment screw (c).

(e) Tighten locking screws. Observing move antenna to original limit to setting. Make small adjustments essary by loosening appropriate and adjustment screws, inching ant exact limit point, then retightening ment and locking screws. Disconne

(2) ***Electrical limit-clockwise alignment.***

(a) Position antenna to 350 degrees cated on antenna control panel 14A IMUTH position indicator. Jump terminals of switch segments A thr if necessary to permit use of servo controls for moving antenna.

(b) Remove any jumpers installed in step (*a*) above and connect vom across segment A NC (+) and C terminals.

(c) Adjust screws A and B on segment A so that contacts just open at 350 ±0.1 degrees and close at 349.6 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(d) If contacts cannot be set as specified in step (c), repeat steps (a) through (c) above, except use opposite adjustment screw in step (c).

(e) Tighten locking screws. Observing cautions, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching antenna to exact limit point, then retightening adjustment and locking screws. Disconnect vom.

(3) ***Electrical limit-counterclockwise alignment.***

(a) Position antenna to 10 degrees as indicated on antenna control panel AZIMUTH position indicator. Jumper the terminals of switch segments A through D to permit use of servo controls for moving the antenna.

(b) Remove any jumpers installed in step (*a*) above and connect vom across segment B NC (+) and C terminals.

(c) Adjust screws A and B on segment B so that contacts just open at 10 ±0.1 degrees and close at 10.4 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(d) If the contacts cannot be set as specified in step (c), repeat steps (a) through (c) above, except use opposite adjustment screw in step (c).

(e) Tighten locking screws. Observing caution, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching antenna to exact limit point, then retightening adjustment and locking screws. Disconnect vom.

(4) ***Servo limit-counterclockwise alignment.***

(a) Position antenna to 15 degrees as indicated on antenna control panel 14A8 AZIMUTH position indicator. Jumper the terminals of switch segments A through D if necessary to permit use of servo controls for moving the antenna.

(b) Remove any jumpers installed in step (*a*) above and connect vom across segment D NC (+) and C terminals.

(c) Adjust screws A and B on segment D so that contacts just open at 15 ±0.1 degrees and close at 15.4 ±0.1 degrees.

NOTE

An open contact is indicated by 26 V dc vom indication. A closed contact is indicated by 0 V dc vom indication.

NOTE

When making adjustments with one adjustment screw, the locking screw on the opposite adjustment screw must be tightened to prevent losing a prior reference. Each adjustment screw has an adjacent locking screw. The procedure may require several attempts to obtain specified limits.

(d) If contacts cannot be set as specified in step (*c*), repeat steps (*a*) through (*c*) above, except use opposite adjustment screw in step (c).

(e) Tighten locking screws. Observing caution, move antenna to original limit to confirm setting. Make small adjustments if necessary by loosening appropriate locking and adjustment screws, inching anten exact limit point, then retightening ad ment and locking screws. Disconnect

SECTION XVIII. MAINTENANCE OF ANTENNA SAFETY INTERLOCK GROUP COMPONENTS

3-113. General. This section provides instructions for replacing components of the antenna safety interlock group. The interlock circuits consist of four antenna safe switches, series connected with the cable-wrap assembly breakway electrical plug connector, and a reflector door switch. (Refer to figure 3-34 for antenna safe switch parts location and identification.)

3-114. Antenna Safe Switch HTA-4A7, 6A9, 8A10, 8A27 Removal and Replacement. This paragraph provides replacement procedures for any of our antenna safe switches (See figure 3-34.) Perform the steps described below.

a. Loosen four captive corner screws and lift cover and attached switch assembly from housing.

b. Repair antenna safe switch by component replacement, as applicable. (Refer to paragraph 3-115).

c. Tag for identification and remove wires from assembly.

d. Identify and connect wires to replacement switch assembly.

e. Attach front cover to housing with four captive screws.

f. Perform test procedures (section XXXV).

3-115. Antenna Safe Switch Components Removal and Replacement. This paragraph provides removal and replacement procedures for the contact block, interlock assembly, and interlock attachment. (See figure 3-34.) After replacement of any component, perform group performance test (section XXXV).

a. Contact Block. To remove and replace the contact block, perform the steps described below:

(1) Loosen the four captive corner screws and lift cover, gasket, and attached switch assembly from housing.

(2) Tag and remove all wires from contact block.

(3) Remove two screws holding interlock attachment (rocker arm) in place.

(4) Remove knurled nut, nomenclature tag, and washer under clear plastic switch cover.

(5) Install nomenclature tag, washer, plastic cover, and knurled nut on replacement contact block.

(6) Install interlock attachment with two screws.

(7) Identify and connect jumper wire and leads to contact block.

(8) Install cover, gasket, and attached switc sembly on housing and secure with four tive screws.

b. Interlock Assembly. To remove and replace interlock assembly, perform the steps described be

(1) Loosen four captive corner screws and lift er, gasket, and attached switch assembly housing.

(2) Remove two screws holding interlock att ment in place.

(3) Remove red ANT, SAFE button, knurled and nomenclature tag, and remove inter assembly.

(4) Install replacement interlock assembly menclature tag, washer, knurled nut, and ANT, SAFE button.

(5) Remount interlock attachment with screws.

(6) Install cover, gasket, and attached switc sembly on housing and secure with four tive screws.

c. Interlock Attachment. To remove and replace interlock attachment, perform the steps described b

(1) Loosen four captive screws and lift cover, ket, and attached switch assembly from ing.

(2) Remove the two screws holding inte attachment in place.

(3) Install replacement interlock attachment two mounting screws.

(4) Install cover, gasket, and attached swit sembly on housing and secure with four tive screws.

3-116. Breakaway Electrical Connector Plug P201 Removal and Replacement. This para provides removal and replacement procedures fo breakaway electrical connector plug. To remove a place the connector, perform the steps described (See figure 1-7, sheet 1.)

a. Loosen four wire rope clamps and unthread rope from eye bolts.

b. Remove eye bolt from back shaft by loo lock nut; remove eye bolt.

c. Unthread wire rope from bulkhead supp bolt and pull connector from jack.

d. Repair assembly by replacement of faulty part.

e. Screw eye bolt of replacement assembly into back shaft.

f. Loosen four wire rope clamps and rethread through eye bolts.

NOTE

The total cable length from eye bolt to eye bolt should be 42 ±3 inches.

g. Tighten the four clamps.

h. Reconnect plug to bulkhead mounted connector.

i. Perform test procedure as described in section XXXV of this chapter.

17. Reflector Door Switch HTA-2A1S1 Removal Replacement. This paragraph provides removal replacement procedures for the antenna reflector ac- door switch. To remove and replace the door switch, rm the following steps.

NOTE

The antenna must be stowed in its zenith position for personnel to gain easy access to the antenna door.

WARNING

When working aloft, at least two men equipped with safety belts and safety lines are required to implement this removal and replacement procedure and to prevent serious injury or death resulting from accidental fall. All tools carried aloft must have safety lines attached to prevent personnel injury due to falling tools.

a. Remove the four screws and remove switch cover.

b. Tag and identify the six leads on switches and disconnect leads from switch terminals.

NOTE

Unlatch the pin ball lock and swing the door open to relieve pressure on the switch roller actuator during removal and replacement procedures.

c. Remove the four screws securing switch to mounting box and remove switch.

d. Install replacement switch on mounting box with four screws.

e. Identify and connect the six wires to switch terminals.

f. Install cover on switch box with four screws.

SECTION XIX. TESTING OF SERVO AND CONTROL EQUIPMENT GROUP

General. This section provides a group level procedure for servo and control equipment. This ould be performed after repair or replacement of nit of the servo and control equipment. When all ments of this section have been met, the servo and control equipment is ready for service.

3-119. Test Equipment and Materials. Table 3-33 lists the test equipment required for group performance test.

Table 3-33 Test Equipment Required for Servo and Control Equipment Group Performance Test Procedure

Common name	Part/model no.	Qty	Manufacturer
d Extender	SM-D-724007	1	Aeronutronic Ford
tifunction	3450B	1	Hewlett-Packard
anana Plug to Test Probe	1986-36-R	1	Pomona
nana Plug to Test Probe	1986-36-B	1	Pomona
ni Test Clip to Mini Test Clip	3781-12	1	Pomona

3-120. Test Connections and Conditions. The group level performance test is performed with the servo and control equipment connected in a normal operational configuration and with the necessary power and signal interfaces connected and operational. (See figure F0-31.) The slave equipment is not considered part of a normal operational configuration for test purposes. A slave source available signal is therefore simulated to provide a test of slave mode logic. Extend antenna position and status panel 14A7 to the maintenance position and make the test connections described below. With the exception that a 3450B multifunction meter with a 1986-36 test lead is used instead of a vom, use figure 3-1 for reference.

a. Connect multifunction meter leads to secant potentiometer (+) and (-) terminals.

NOTE

The secant potentiometer is part of the elevation antenna position indicator synchro in antenna position and status panel 14A7.

b. Verify or set all circuit breakers on servo power supply assembly to TRIPPED or down position. Remove cover from antenna position and status panel 14A7 electrical equipment chassis and extract relay circuit card assembly A5. Install card extender in the A5 position and connect relay circuit card assembly A5 to extender. Install 3781-12 test lead from TB2B-FW on antenna position and status panel to XA5 B1 interface on extender card.

3-121. Initial Control Settings. Verify or set the switches listed below as indicated:

a. *Direct current control HTA-9.*
   (1) Elevation electronic control amplifier OPERATE switch set to NORMAL.
   (2) Azimuth electronic control amplifier OPERATE switch to NORMAL.

b. *Servo power supply assembly 14A9.*
   (1) SYNCHRO REF 120 VAC circuit break ON.
   (2) PRIMARY POWER CIRCUIT BREA ERS (4) to ON.
   (3) 26 V dc OUTPUT EQPT circuit break ON.

c. *Stow pin control/minor fault summary p HTA-8A24.* Set power switch/circuit break ON.

d. *Antenna position and status panel 14A7.* Ro antenna safe key switch to operate (clockw position.

e. *Antenna control panel 14A8.* STANDBY MO indicator switch pressed to standby mode.

f. *Multifunction meter.*

Control	Positio
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
LINE	On (ac
TRIGGER	INT
RATE	Max co maxim sampl rate

3-122. Test Procedure. Perform steps in table in the order presented. When the servo and control ment has met the requirements of the performan procedure, restore the equipment to the operational guration.

Table 3-34 Servo and Control Equipment Group Performance Test Procedure

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1			Observe MODE indicators on antenna control panel.	STANDBY MODE indicator lit, others out.
2			Press MANUAL MODE indicator switch on antenna control panel.	MANUAL MODE indicator lights, STANDBY MODE indicator goes out.

Table 3-34 Servo and Control Equipment Group Performance Test Procedure - Continued

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
		Using SLEW controls and position indicators on antenna control panel, drive antenna to 90-deg elevation/180-deg azimuth position.	a. Observe antenna position and status panel STATUS indicators.	a. All STATUS switch indicators are out.
			b. Observe stow pin control/minor fault summary panel MINOR FAULT SUMMARY indicators.	b. All indicator switches are out. (If MAINTENANCE indicator is lit, press to extinguish.)
			c. Observe indicators on direct current control azimuth and elevation electronic control amplifier circuit card assemblies.	c. All yellow indicators listed below are lit; all red indicators are out as follows: Yellow INTLK OK MOT 1 FLD MOT 2 FLD +15 Gate +26V +15V -15V +5V Red MNL BK RLSE PHASE REF MOT 1 PH A FU MOT 1 PH B FU MOT 1 PH C FU MOT 2 PH A FU MOT 2 PH B FU MOT 2 PH C FU MOT 1 OVLD MOT 2 OLVD
			d. Observe indicators on antenna position and status panel.	d. ELEVATION position indicator - 90 deg (approximate); azimuth position indicator -180 deg (approximate)
		Press RAIN DEF ON indicator switch on stow pin control/minor fault summary panel to operate status.		RAIN DEF ON indicator lights.
		Press RAIN DEF ON indicator switch on stow pin control/minor fault summary panel to off status.		RAIN DEF ON indicator goes out within 30 seconds.
		Press AZIMUTH STOW and ELEVATION STOW indicator switches (simultaneously or separately) on stow pin control minor fault summary panel and hold down until both STOW indicators are lit.		RETRACT indicators go out, IN TRANSIT light and remain lit until STOW indicators light (approximately 15 seconds).
		Press AZIMUTH RETRACT and ELEVATION RETRACT indicator switch on stow pin control/minor fault summary panel and hold down until both RETRACT		STOW indicators go out, IN TRANSIT indicators light and remain lit until RETRACT indicator lights.

Table 3-34 Servo and Control Equipment Group Performance Test Procedure - Continued

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
		indicators are lit.		
8		Turn MONITOR switch on servo power supply assembly to each voltage position, then to OFF.		VOLTAGE meter indicates in the green area for each output posi
9			At azimuth electronic control amplifier, disconnect connectors J1 and J2.	
10		Using ELEVATION handcrank on antenna control panel, drive antenna to 89-deg position (1 turn CCW).		
11		Rotate EL SLEW comtrol on antenna control panel to maximum CW for minimum time to read multifunction meter.	Observe multifunction meter indication.	10.0 ±0.01 V dc
12			Disconnect one lead of the multifunction meter from the secant potentiometer and connect to terminal C of the secant potentiometer, then repeat step 11.	±0.1728 to 0.1762 V dc
13			Reconnect J1 and J2 removed in step 9.	
14		Press SLAVE MODE indicator switch on antenna control panel.		SLAVE MODE indicator lights. MANUAL MODE indicator g out.
15		Press ACQUISITION MODE indicator switch on antenna control panel.		ACQUISITION MODE indicator lights within 4 seconds. AUTO TRACK MODE indicator light MANUAL and ACQUISITION dicators go out.

SECTION XX. TESTING OF ANTENNA CONTROL PANEL 14A8

3-123. General. Antenna control panel 14A8 is to be performance tested after replacement of integral assemblies, subassemblies, or modules following the completion of troubelshooting procedures described in section III and/or maintenance procedures in section XI. After replacement of component parts, the antenna control panel is installed in the operational configuration and tested a the servo and control equipment group (section

3-124. Subassembly Performance Testing. A control panel instrument servo assemblies 14A8 14A8A2 are tested individually in a bench test co tion. (Refer to section XXI.)

SECTION XXI. TESTING OF INSTRUMENT SERVO ASEMBLY 14A8A1, A8A2

-125. **General.** This section contains the procedures ecessary for performance testing of antenna control pan- l 14A8 azimuth or elevation instrument servo assem- lies, after replacement of integral assemblies, bassemblies, or modules. Performance testing follows e completion of troubleshooting procedures described in ction III and/or maintenance procedures described in ction XI. Each of the preliminary procedures and the rformance test must be performed in the sequence pre- nted. Preliminary procedures consist of obtaining the ed test equipment, making the prescribed test connec- ns, and initially setting the equipment controls to the ecified settings. These settings, and all subsequent set- gs given in the performance test table, must be made refully to ensure accurate test conditions. If the instru- nt servo assembly meets all performance standards ecified in the performance test, the equipment can be tified for return to service.

26. **Test Equipment and Materials.** Test equip- nt and materials required for the performance test are same as required for troubleshooting (table 3-3).

3-127. Test Connections and Conditions. Test connections and conditions required for the performance test are the same as for troubleshooting (fig. 3-4).

3-128. Initial Control Settings. Initial control settings are the same as for troubleshooting (section III, para 3-15*c*).

3-129. Performance Test Procedure. Table 3-35 contains the test procedures for the instrument servo assembly. Proceed sequentially through the table in accordance with the numbered steps. Set test equipment controls and equipment under test controls exactly as given in the table and perform the prescribed test procedure. If the result is within the specified performance standard limits, proceed to the next step in the table. If the result is not as specified, perform the troubleshooting procedure in section III. After fault correction, repeat the performance test. When the instrument servo assembly has met the requirements of the performance test procedure, restore equipment to the operational configuration.

Table 3-35 Instrument Servo Assembly 14A8A1, A8A2 Performance Test Procedure

tep	Control settings		Test procedure	Performance standard
	Test equipment	**Equipment under test**		
	As specified in paragraph 3-15c.		Connect vom with B-48 test leads and 3560 adapters to J1 pins as indicated below and read resistance on vom for each test. a. Pins A, B b. Pins W, D c. Pins D, E d. Pins E, W e. Pins W, C f. Pins D, C g. Pins E, C h. Pins Y, F i. Pins F, G j. Pins G, Y k. Pins Y, C l. Pins F, C m. Pins G, C n. Pins S, R	a. 40 ohms (maximum) b. 1500 ohms (see note 1) c. 1500 ohms (see note 1) d. 1500 ohms (see note 1) e. Infinite f. Infinite g. Infinite h. 1500 ohms (see note 2) i. 1500 ohms (see note 2) j. 1500 ohms (see note 2) k. Infinite l. Infinite m. Infinite n. 750 + 75 ohms

Table 3-35 Instrument Servo Assembly 14A8A1, A8A2 Performance Test Procedure - Continued

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
				F n. 750 ±75 ohms Notes 1. Actual resistance may vary, b three tests (b, c, and d) must same. 2. Actual resistance may vary, b three tests (h, i, and j) must same.
	o. Vom range switch set to Rx100.		o. Pins A, B	o. 15 ohms (+ lead to A), 100 (- lead to A)
			p. Pins S, C q. Pins R, C r. Pins J, F	p. 2000 to 4000 ohms q. 2000 to 4000 ohms r. 51,000 (nom) -check resistor R color code for actual resistance
2			Connect vom test leads to K1 pins 1 and 3 and read resistance.	Less than 1 ohm
3		Turn on power supply and read resistance.	Move K1 pin 1 test lead to K1 pin 5, connect dual-output power supply with B-48 test leads and 3560 adapters to J1-A(+) and J1-B(-).	Less than 1 ohm
4			Turn off power supply, connect vom to K1 pins 6 and 8 and read resistance.	Less than 1 ohm
5			Move K1 pin 8 test lead to K1 pin 4, turn on power supply and read resistance.	Less than 1 ohm
6			Disconnect vom from K1 and turn off power supply.	None
7	Vom function switch to AC, and range switch to 50 V.		Connect 17449 test lead with 2894 adapters to 3560 adapters at pins J1A and J1B. Connect vom test leads to PS1 pins 1 and 4 and read ac voltage, then disconnect vom test leads.	32 ±3.2 V ac
8	Vom function switch to DC.		Connect vom test leads to PS1 pins 3 and 2 and read dc voltage, then disconnect vom test leads.	42 ±4.2 V ac
9			Connect function generator 1166-36 test leads to AR1-J2, pins A and B. Connect multifunction meter 1166-36 test leads to K1, pins 1 and 8.	Instrument servo digital counter to upcount.
10		Turn on function generator and		

Table 3-35 Instrument Servo Assembly 14A8A1, A8A2 Performance Test Procedure - Continued

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
		adjust output for 60 ±3 Hz at 1 ±0.1 V ac rms indication on multifunction meter.		
1		Press FUNCTION DC switch on multifunction meter.	Move multifunction meter 1166-36 test leads to AR1 output, J2 pins E and F. Read AR1 output on multifunction meter.	Multifunction meter indicates 40 V ac rms. Instrument servo digital counter upcounts and then reverses.

SECTION XXII. TESTING OF ANTENNA POSITION AND STATUS PANEL 14A7

-130. **General.** Antenna position and status panel 4A7 is to be performance tested after replacement of egral assemblies, subassemblies, or modules, following mpletion of troubleshooting procedures described in ction IV and/or maintenance procedures described in ction XII. After replacement of component parts, the tenna position and status panel is installed in the operational configuration and tested as part of the servo and control equipment group (section XIX).

3-131. Subassembly Performance Testing. Antenna position and status panel 14A7 circuit card assemblies are tested individually. Refer to higher level maintenance.

Section XXIII. TESTING OF SERVO POWER SUPPLY ASSEMBLY 14A9

132. **General.** Servo power supply assembly 14A9 to be performance tested after replacement of integral emblies, subassemblies, or modules following the comtion of troubleshooting procedures described in section and/or maintenance procedures described in section III. After replacement of component parts, the servo wer supply assembly is installed in the operational conuration and tested as part of the servo and control ipment group (section XIX).

3-133. Subassembly Performance Testing. Servo power supply assembly power supplies 14A9PS2, A9PS3, A9PS4 are tested individually in separate bench test configurations. (See section XXIV for the +15 V dc and -15 V dc power supplies PS2 and PS3 test, and section XXV for the +5 V dc power supply PS4 test.) Refer to higher maintenance for testing of +26 V dc power supply 14A9PS1.

SECTION XXIV. TESTING OF +15 V DC AND -15 V DC POWER SUPPLY 14A9PS2, A9PS3

134. **General.** This section contains the procedures essary for performance testing +15 V dc and -15 V dc er supplies PS2 and PS3 after replacement of units lowing the troubleshooting procedures. Each prelimiy procedure and performance test must be performed the given sequence. The preliminary procedure consists obtaining the listed test equipment, making the preibed test connections, and initially setting the equipnt controls to the specified settings. These settings, and all subsequent settings given in the performance test table, must be made carefully to ensure accurate test conditions. If the test procedures result in the power supply meeting all performance standards specified in the performance test, the equipment can be returned to service.

3-135. Test Equipment and Materials. Test equipment required for testing of the 15 V dc power supply is the same as that required for overcurrent control R17 adjustment, and is listed in table 3-26.

3-136. Test Connections and Conditions. Performance testing of the power supply is accomplished in a bench test setup. Prior to performing the performance test, prepare the equipment as follows:

a. Set vom function switch to AC and range switch to 250 V. Connect vom to variable output plug transformer.

b. Connect variable power transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

c. Adjust carbon compression rheostat for maximum resistance (fully ccw).

d. Connect test equipment as shown in figure 3-36.

NOTE

Twist test leads on multifunction meter, rheostat, and ammeter thaf connect to power supply to cancel external noise signals.

3-137. Initial Control Settings. The initial co settings for the performance test are the same as th specified in paragraph 3-72*c*.

3-138. Performance Test Procedure. Table contains the test procedure for either 15 V dc p supply. Proceed sequentially through the table in acc ance with the numbered steps. Set the test equip controls and equipment under test controls as direct the table and perform the prescribed test procedure result is within the specified performance standard proceed to the next step in the table. If the result as specified, perform the troubleshooting procedur section V. After fault correction, repeat the perform test.

Table 3-36 15 V DC and -15 V DC Power Supply 14A9PS2, A9PS3 Performance Test Procedure

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
	As specified in paragraph 3-136.		Observe multirange dc ammeter and adjust carbon compression rheostat for value specified as performance standard.	2.2 A
			Disconnect test lead from positive post of multirange dc ammeter.	
			Adjust power supply VDC control to obtain specified output voltage indication on multifunction meter.	15 ±0.75 V dc
			a. Record multifunction meter indication as V1.	
			b. Reconnect test lead to multirange dc ammeter and record multifunction meter indication as V2.	
			c. Load regulation is difference between V1 and V2. Calculate this difference.	Equal to or less than 7.5 mV dc
			a. Set multifunction meter LINE switch to off.	
			b. Observe dual-trace oscilloscope display and measure the ripple voltage and noise.	Equal to or less than 3 mV p-p
			Set multifunction meter LINE switch to on.	
			a. Adjust variable transformer for a 132 V ac indication on vom.	
			b. Record the multifunction meter indication as V3.	
			a. Adjust variable transformer for 105 V ac indication on vom and record multifunction meter indication as V4. V4.	
			b. Calculate line regulation as the difference between V3 and V4.	Equal to or less than 11.5 mV dc

SECTION XXV. TESTING OF +5 V DC POWER SUPPLY 14A9PS4

3-139. General. This section contains the procedures necessary for performance testing +5 V dc power supply 14A9PS4 after replacement of components following the troubleshooting procedures. Each preliminary procedure and performance test must be performed in the given sequence. The preliminary procedure consists of obtaining the listed test equipment, making the prescribed test connections, and initially setting the equipment controls to the specified settings. These settings, and all subsequent settings given in the performance test table, must be made carefully to ensure accurate test conditions. If the test procedures result in the +5 V dc power supply meeting all performance standards specified in the performance test, the equipment can be returned to service.

3-140. Test Equipment and Materials. Test equipment required for testing of the +5 V dc power supply is the same as that required for overcurrent control R17 adjustment and is listed in table 3-26.

3-141. Test Connections and Conditions. Performance testing of the power supply is accomplished in a bench test setup. Prior to performing the performance test, prepare the equipment as follows:

a. Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

b. Connect variable power transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication on vom. Set variable former power switch to OFF. Disconnec

c. Adjust carbon compression rheostat for ma resistance (fully ccw).

d. Connect test equipment as shown in figur

NOTE

Twist test leads on multifunction meter, rheostat, and ammeter that connect to power supply to cancel external noise signals.

3-142. Initial Control Settings. The initial co settings for the performance test are the same as specified in paragraph 3-73.

3-143. Performance Test Procedure. Table contains the test procedure for the +5 V dc power su Proceed sequentially through the table in accor with the numbered steps. Set the test equipment co and equipment under test controls as directed in the and perform the prescribed test procedure. If the is within the specified performance standard proceed to the next step in the table. If the result as specified, perform the troubleshooting procedu section V. After fault correction, repeat the perform test.

Table 3-37 5 V DC Power Supply 14A9PS4 Performance Test Procedure

Step	Control settings		Test procedure	Performance stand
	Test equipment	Equipment under test		
1	As specified in paragraph 3-141.		Observe multirange dc ammeter and adjust carbon compression rheostat for value specified as performance standard.	2.7 A
2			Disconnect test lead from positive post of multirange dc ammeter.	
3			Adjust power supply VDC control to obtain specified output voltage indication on multifunction meter.	5 ±0.75 V dc
4			a. Record multifunction meter indication as V1. b. Reconnect test lead to multirange dc ammeter and record multifunction meter indication as V2. c. Load regulation is difference between V1 and V2. Calculate this difference.	Equal to or less than 1.5

Table 3-37 5 V DC Power Supply 14A9PS4 Performance Test Procedure - Continued

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
			a. Set multifunction meter LINE switch to off. b. Observe dual-trace oscilloscope display and measure the ripple voltage and noise.	Equal to or less than 1 mV p-p
			Set multifunction meter LINE switch to on.	
			a. Adjust variable transformer for a 132 V ac indication on vom. b. Record the multifunction meter indication as V3.	
			a. Adjust variable transformer for 105 V ac indication on vom and record multifunction meter indication as V4. b. Calculate line regulation as the difference between V3 and V4.	Equal to or less than 1.5 mV dc

SECTION XXVI. TESTING OF STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24

144. **General.** Stow pin control/minor fault sum- ry panel HTA-8A24 is to be tested for performance er replacement of integral assemblies, subassemblies, modules, following the completion of troubleshooting cedures described in section VI and/or maintenance cedures described in section XIV. After replacement component parts, the stow pin control/minor fault mary panel is installed in the operational configuration and tested as part of the servo and control equipment group (section XIX).

3-145. Subassembly Performance Testing. Stow pin control/minor fault summary panel HTA-8A24 power supply PS1 is tested as part of the assembly, after adjustment or replacement of the power supply. Refer to higher level maintenance for a bench test of PS1.

SECTION XXVII. TESTING OF DIRECT CURRENT CONTROL HTA-9

6. **General.** Direct current control HTA-9 is to performance tested after replacement of integral as- blies, subassemblies, or modules, following the com- ion of troubleshooting procedures described in section and/or maintenance procedures described in section . After replacement of component parts, the direct ent control is connected in the operational configura- and tested as part of the servo and control equipment p (section XIX).

7. **Subassembly Performance Testing.** Direct ent control electronic control amplifiers HTA-9A2, 9A3 and power supply control HTA-9A1 are tested individually in the operational configuration (sections XXVIII and XXIX respectively. The +5 V dc power supply HTA-9A1PS1, the dual 15 V dc power supply HTA-9A1PS2, and the +15 V dc gate power supply HTA-9A1PS3 performance tests are provided in sections XXX through XXXII, respectively. The individual tests also provide performance testing of direct current control cabinet-mounted components associated with the respective subassembly.

SECTION XXVIII. TESTING OF ELECTRONIC CONTROL AMPLIFIER HTA-9A2, 9A3

3-148. General. This section contains the procedures necessary for performance testing electronic control amplifier HTA-9A2 or HTA-9A3. The procedure requires that the unit be installed in an operational configuration with the power supply control and cabinet-mounted components installed and operational. The test should be performed after repair or replacement of the unit or of a subassembly or component part. The major subas lies of an electronic control amplifier are the circu assembly A1 and scr assemblies A2 through A7. Re higher level maintenance for circuit card and scr a bly bench tests.

3-149. Test Equipment. Table 3-38 lists the equipment required for the performance test.

Table 3-38 Test Equipment Required for Electronic Control Amplifier HTA-9A2, 9A3 Performance Test Procedure

Common name	Part/model no.	Qty	Manufactur
Adapter, BNC Plug to Dual Binding Post	103-0035-00	1	Tektronix
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Adapter, 14 or 16 Pin DIP Test Clip	3916	1	Pomona
Milliammeter, Volt-Ohm (VOM)	260-6	1	Simpson
Oscilloscope, Dual-Trace	475	1	Tektronix
Test Lead, Banana Plug to Banana Plug	B-48	2	Pomona
Test Lead, Mini Test Clip to Mini Test Clip	3781-12	2	Pomona

3-150. Test Connections and Conditions (Fig 3-42). Electronic control amplifier A2 or A3 is connected in the operational configuration. Test equipment layout is shown in figure 3-41. Test connections are specified in the performance table.

3-151. Initial Control Settings. All controls on servo and control equipment are set for normal operation. Set test equipment controls as follows:

Control	Position
Oscilloscope	
POWER	On (Pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe signal
CH1 AC-GND-DC	DC
HORIZ DISPLAY	A-LOCK KNOBS
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required t observe sign
A TRIGGER-SLOPE and LEVEL	As requi stable displa
Vom	
Range	10V
Function	AC

3-152. Performance Test Procedure. Table contains test procedures for electronic control am A2 or A3. Proceed sequentially through the table i cordance with the numbered steps. If the test resul a step are within specified limits, proceed to the next in the table; if the results are not within specified l perform the necessary troubleshooting procedure i

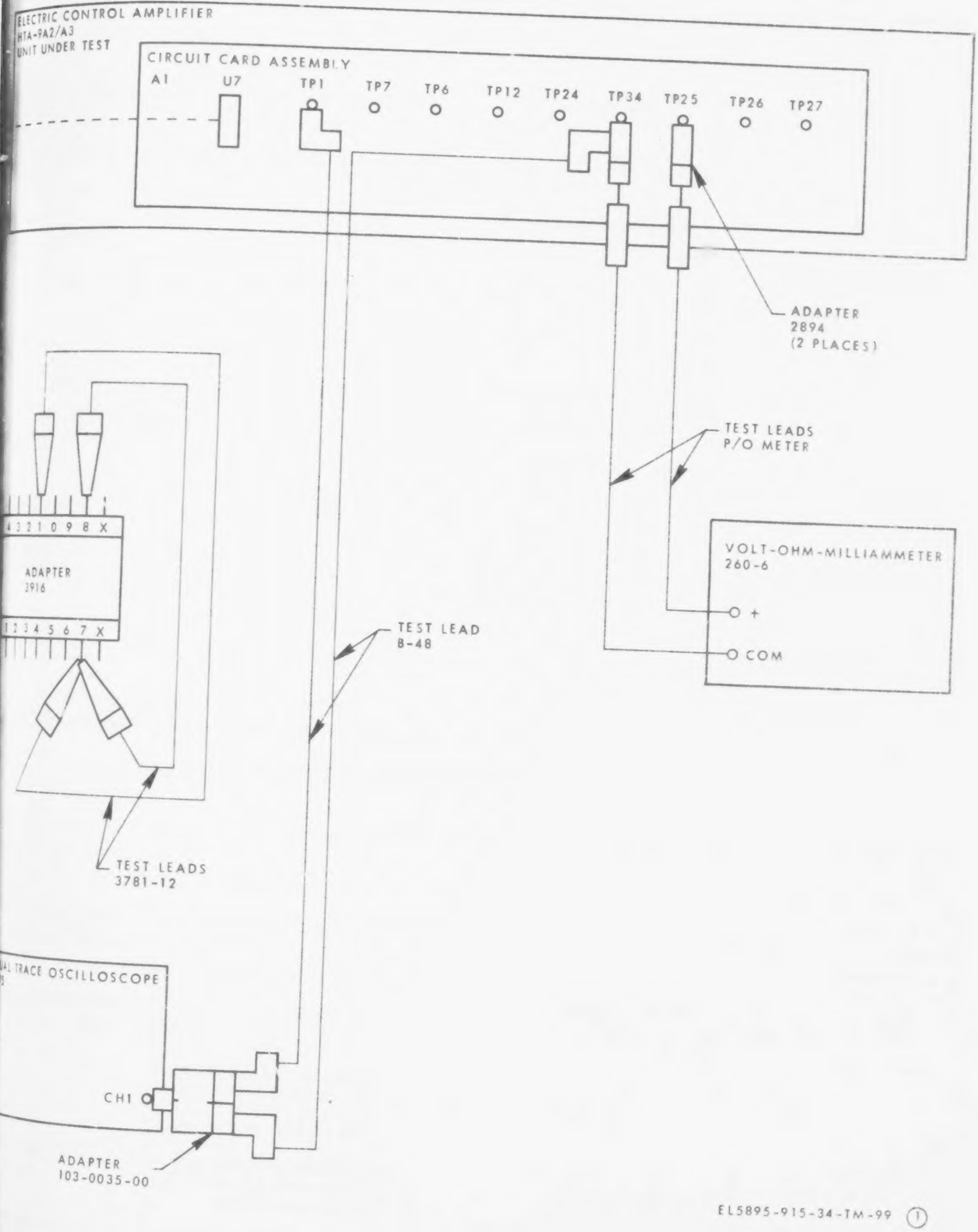

ELECTRIC CONTROL AMPLIFIER
HTA-9A2/A3
UNIT UNDER TEST
CIRCUIT CARD ASSEMBLY
A1
U7
TP1
TP7
TP6
TP12
TP24
TP34
TP25
TP26
TP27
ADAPTER
2894
(2 PLACES)
TEST LEADS
P/O METER
VOLT-OHM-MILLIAMMETER
260-6
+
COM
TEST LEAD
B-48
4 3 2 1 0 9 8 X
ADAPTER
3916
1 2 3 4 5 6 7 X
TEST LEADS
3781-12
UAL TRACE OSCILLOSCOPE
CH1
ADAPTER
103-0035-00
EL5895-915-34-TM-99 ①

Figure 3-41. *Electronic control amplifier HTA-9A2, 9A3, performance test, test setup diagram (sheet 1 of 2).*

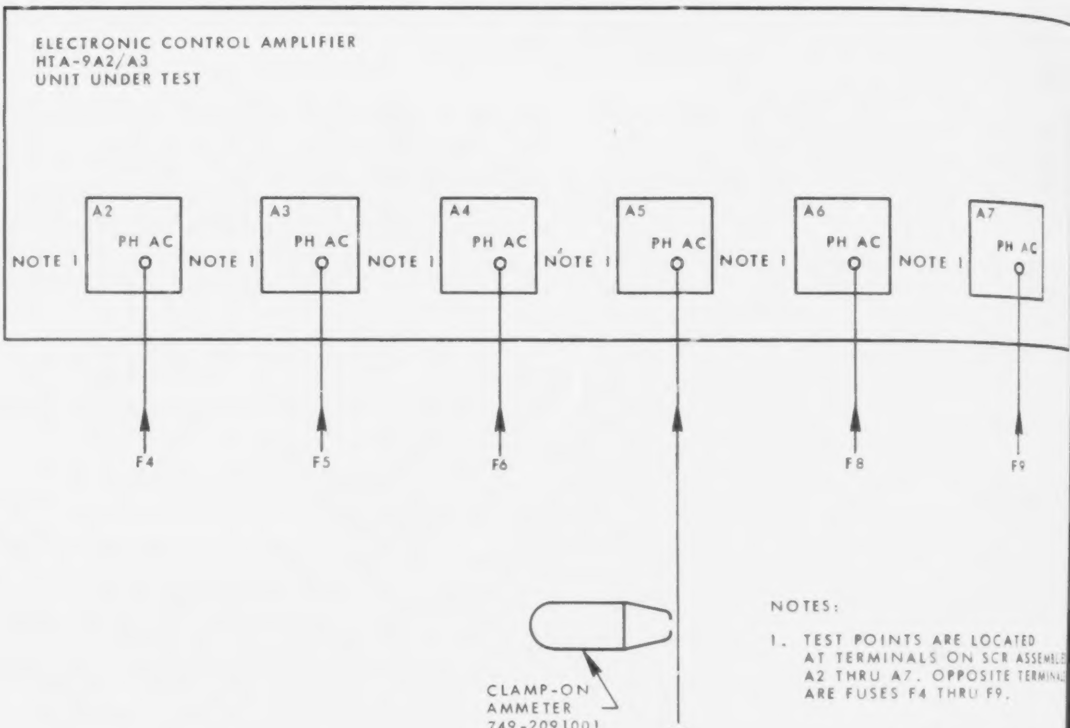

ELECTRONIC CONTROL AMPLIFIER
HTA-9A2/A3
UNIT UNDER TEST
A2
PH AC
NOTE 1
A3
PH AC
NOTE 1
A4
PH AC
NOTE 1
A5
PH AC
NOTE 1
A6
PH AC
NOTE 1
A7
PH AC
NOTE 1
F4
F5
F6
F8
F9
CLAMP-ON
AMMETER
749-2091001
F7
NOTES:
1. TEST POINTS ARE LOCATED AT TERMINALS ON SCR ASSEMBL A2 THRU A7. OPPOSITE TERMINAL ARE FUSES F4 THRU F9.
EL5895-915-34-TM-

Figure 3-41. Electronic control amplifier HTA-9A2, 9A3, performance test, test setup diagram (sheet 2 of

tion VII. After fault correction, repeat the performance test.

Table 3-39 Electronic Control Amplifier HTA-9A2, 9A3 Performance Test Procedure

Step no.	Control settings		Test procedure	Performance stan
	Test equipment	Equipment under test		
1	As specified in paragraph 3-150	On circuit card assembly A1, set LOCAL switch to OFF and OPERATE switch to LOCAL.	On circuit card assembly A1, connect (-) lead of vom to TP34 and measure ac voltage at TP25, TP26 and TP27 with (+) lead.	7.7 ±1.0 V ac
2			With oscilloscope channel 1 test probe, monitor TP1 thru TP12. (negative lead at TP34).	4.5 ±0.5 V dc pulses
3		On circuit card assembly A1, set SLEW potentiometer at 50 pct	With oscilloscope, monitor trigger pulses (2.2 ±1.0 ms at 16 to 20	Negative going pulses fro ±0.5 V dc to less than

Table 3-39 *Electronic Control Amplifier HTA-9A2, 9A3 Performance Test Procedure - Continued*

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
		clockwise position and LOCAL switch to SLEW.	ms intervals) on TP1 thru TP12 (negative lead at TP34).	
			With oscilloscope, monitor differential tach at TP24.	1 V p-p (max) sine wave
			a. With oscilloscope, monitor motor 1 differential output at TP13.	2.5 V p-p (max) sawtooth
			b. With oscilloscope, monitor motor 2 differential output at TP14.	2.5 V p-p (max) sawtooth
	On oscilloscope, adjust channel 1 and 2 position controls so that baselines overlap.	Set LOCAL switch to SLEW and OPERATE switch to LOCAL. Rotate SLEW potentiometer fully CCW.	Place 3916 adapter (fig. 3-42) onto U7. Connect CHAN 1 of oscilloscope to TP27 and CHAN 2 to TP15.	CHAN 2 waveform 0.2 V dc ±10 pct less than peak of CHAN 1
		Set LOCAL switch to OFF and OPERATE switch to NORMAL. On antenna control panel, select manual mode.		Vertical deflection of CHAN 1 and CHAN 2 is equal.
			Disconnect test equipment and observe LED indicators on A1.	LED indicators DS1 thru DS6, DS14 thru DS16, and DS19 are extinguished. LED indicators DS7 thru DS13, DS17, and DS18 are illuminated.

SECTION XXIX. TESTING OF POWER SUPPLY CONTROL HTA-9A1

53. **General** This paragraph contains procedures testing power supply control HTA-9A1 after repair or cement of a subassembly or component part.

54. **Test Equipment.** Test equipment required for performance test is a 260-6 vom.

55. **Test Connections and Conditions.** Power ply control A1 is connected in the operational confi- tion using vom test leads for probe testing.

3-156. Initial Control Settings. Set vom range switch to 250 V and function switch to AC.

3-157. Performance Test Procedure. Table 3-40 contains the test procedure for the power supply control. Proceed sequentially through the table. If test results for a step are within specified limits, proceed to the next step; if specified limits are not met, perform the necessary troubleshooting procedures in section VII. After fault correction, repeat the performance test.

Table 3-40 Power Supply Control HTA-9A1 Performance Test Procedure

Step	Control settings		Test procedure	Performance standar
	Test equipment	Equipment under test		
1	As specified in paragraph 3-155.	As specified in paragraph 3-154.	Connect (-) lead of vom to TB2-16 and (+) lead to TB3-14 and TB3-15.	240 ±24 V ac
2			Connect (-) lead of vom to TB2-16 and (+) lead to TB2-14 and TB2-15.	240 ±24 V ac
3			Connect (-) lead of vom to TB3-20 and (+) lead to TB2-1, TB2-2, TB2-3, TB2-10, TB2-12, and TB2-19.	120 ±12 V ac
4			Connect (-) lead of vom to TB3-20 and (+) lead to TB3-1, TB3-2, TB3-3, TB3-10, TB3-17, TB3-18, and TB3-19.	120 ±12 V ac
5	On vom, set range switch to 10 V and function switch to +DC.		Connect (+) lead of vom to TB1-17 and (-) lead to TB1-18.	+5 ±0.5 V dc
6	On vom, set range switch to 50 V.		Connect (+) lead of vom to TB1-12 and (-) lead to TB1-13.	+15 ±0.75 V dc
7			Connect (-) lead of vom to TB1-12 and (+) lead to TB1-14 and TB1-15.	+15 ±0.75 V dc
8			Connect (+) lead of vom to TB1-15 and (-) lead to TB1-16.	-15 ±0.75 V dc
9			Connect (-) lead of vom to TB1-16 and (+) lead to TB2-7.	+12 V dc, maximum
10			Connect (-) lead of vom to TB1-16 and (+) lead to TB2-9.	+12 V dc, maximum
11			Connect (-) lead of vom to TB1-16 and (+) lead to TB3-7.	+12 V dc, maximum
12			Connect (-) lead of vom to TB1-16 and (+) lead to TB3-9.	+12 V dc, maximum

SECTION XXX. TESTING OF +5 V DC POWER SUPPLY HTA-9A1PS1

158. **General.** This section contains the procedures cessary for performance testing +5 V dc power supply TA-9A1PS1 after replacement of components follow- the completion of troubleshooting or maintenance ocedures. Each preliminary procedure and perform- ce test must be performed in the given sequence. The liminary procedure consists of obtaining the listed test uipment, making prescribed test connections, and ini- lly setting equipment controls to the specified settings. These settings, and all subsequent settings given in the performance test table, must be made carefully to ensure accurate test conditions. If the test procedures result in the +5 V dc power supply meeting all performance standards specified in the performance test, the equipment can be returned to service.

3-159. Test Equipment and Materials. Table 3-41 lists the test equipment required for the performance test.

Table 3-41 Test Equipment Required for 5 V DC Power Supply HTA-9A1PS1 Performance Test Procedure

Common name	Part/model no.	Qty	Manufacturer
Line Cord	17449-S	1	Belden
ter, Ac, 3-Wire to 2-Wire	785-0419	1	Allied
ter, Banana Jack to Minigator Clip	3448	7	Pomona
ter, Single Banana Plug to Binding Post	2894	2	Pomona
ter, DC, Multirange	931-2902001	1	Weston Instruments
Multifunction	3450B	1	Hewlett-Packard
meter, Volt-Ohm- (VOM)	260-6	1	Simpson
ope, Dual-Trace	475	1	Tektronix
Carbon Compression	82905	1	Central Scientific
Lead, Banana Plug to Alligator Clip	1166-36-B	1	Pomona
Lead, Banana Plug to Banana Plug	B-48(B)	3	Pomona
Lead, Banana Plug to Banana Plug	B-48(R)	2	Pomona
Lead, BNC Plug to Double Banana Plug (44″)	11001A	1	Hewlett-Packard
Lead, Spade Lug to Banana Plug	1307-24-B	1	Pomona
Lead, Spade Lug to Banana Plug	1307-24-R	1	Pomona
Lead, Spade Lug to Spade Lug	1743-36-R	1	Pomona
mer, Variable	3PN2210	1	Pomona

Test Connections and Conditions. mance testing of power supply HTA-9A1PS1 is plished in a bench test setup. Prior to performing formance test, prepare the equipment as follows:

Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

b. Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable transformer for 115 V ac indication. Set variable transformer power switch to OFF. Disconnect vom.

c. Adjust carbon compression rheostat for maximum resistance (fully ccw).

d. Connect test equipment as shown in figure 3-42.

NOTE

Twist test leads on multifunction meter, rheostat and ammeter that connect to power supply to cancel external noise signals.

3-161. Initial Test Equipment Settings. Initial test equipment settings for the performance test are as follows:

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Oscilloscope	
POWER	On (pull)
VERT MODE	CH 1
CH 1 VOLTS/DIV	As required to observe signal
CH 1 AC-GND-DC	AC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER - SLOPE and LEVEL	As required for stable display
Variable transformer	
Power switch	ON

3-162. Performance Test Procedures. Table contains the test procedure for +5 V dc power HTA-9A1PS1. Proceed sequentially through the ta accordance with the numbered steps. Set the test e ment controls and equipment under test controls as given in the table and perform the prescribed procedure. If the result is within specified perform standard limits, proceed to the next step in the ta the result is not as specified, perform the troublesho

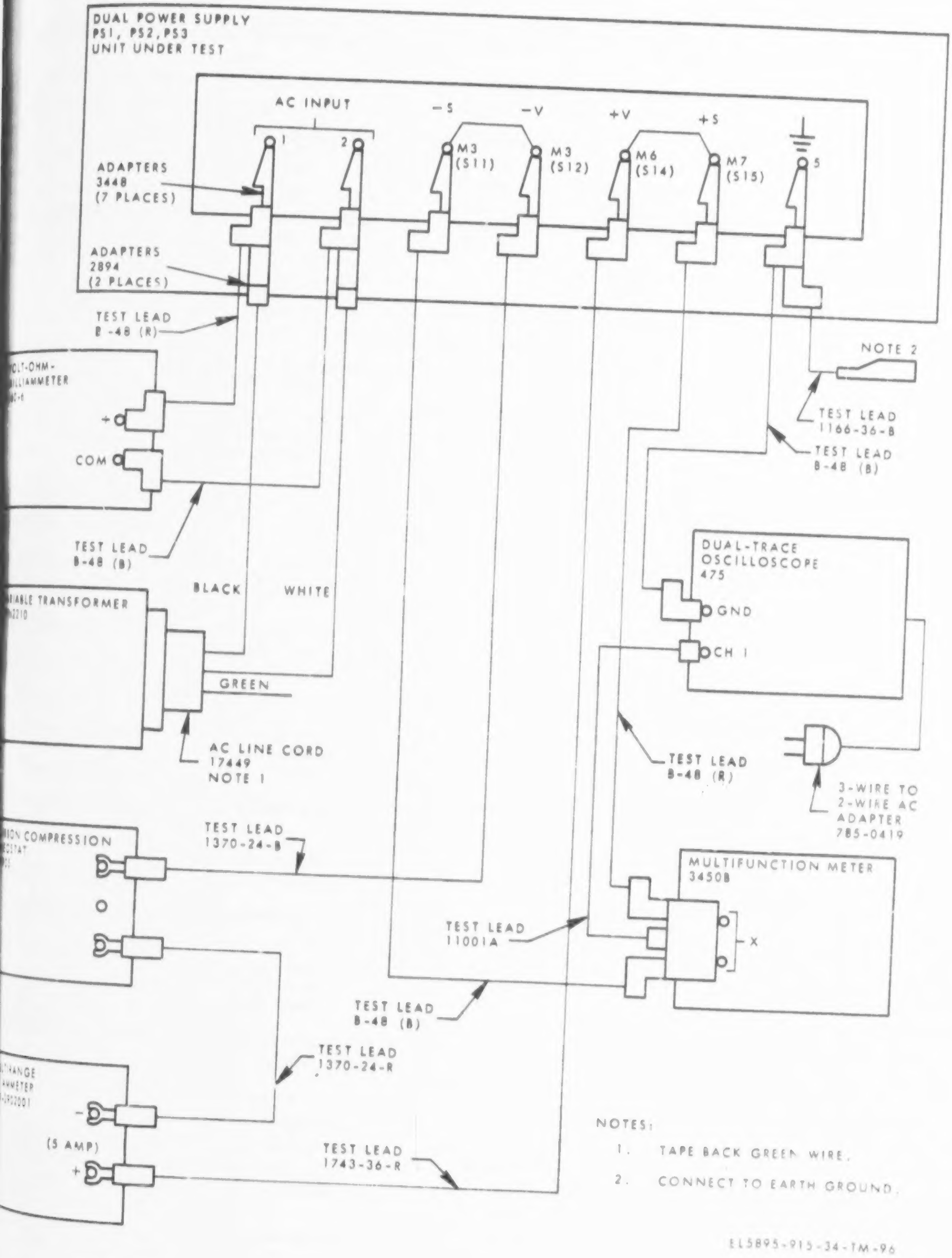

DUAL POWER SUPPLY
PS1, PS2, PS3
UNIT UNDER TEST
AC INPUT
1
2
-S
-V
+V
+S
M3 (S11)
M3 (S12)
M6 (S14)
M7 (S15)
5
ADAPTERS 3448 (7 PLACES)
ADAPTERS 2894 (2 PLACES)
TEST LEAD B-48 (R)
OLT-OHM-
ILLIAMMETER
+
COM
TEST LEAD B-48 (B)
BLACK
WHITE
RIABLE TRANSFORMER
2210
GREEN
AC LINE CORD 17449 NOTE 1
NOTE 2
TEST LEAD 1166-36-B
TEST LEAD B-48 (B)
DUAL-TRACE OSCILLOSCOPE 475
GND
CH 1
TEST LEAD B-48 (R)
3-WIRE TO 2-WIRE AC ADAPTER 785-0419
ION COMPRESSION
TEST LEAD 1370-24-B
MULTIFUNCTION METER 3450B
X
TEST LEAD 11001A
TEST LEAD B-48 (B)
TEST LEAD 1370-24-R
LTIRANGE
AMMETER
-2902001
-
(5 AMP)
+
TEST LEAD 1743-36-R
NOTES:
1. TAPE BACK GREEN WIRE.
2. CONNECT TO EARTH GROUND.
EL5895-915-34-TM-96

Figure 3-42. Power supply HTA-9A1PS2, performance test, test setup diagram.

procedure in paragraph 3-36, section VII of this chapter. After fault correction, repeat the performance test

Table 3-42 5 V DC Power Supply HTA-9A1PS1 Performance Test Procedure

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	As specified in paragraph 3-160.		Observe multirange dc ammeter and adjust carbon compression rheostat for value specified as performance standard.	2.7 A
2			Disconnect test lead from positive post of multirange dc ammeter.	
3			Adjust power supply VDC control to obtain specified output voltage indication on multifunction meter.	5 ± 0.75 V dc
4			a. Record multifunction meter indication as V1.	
			b. Reconnect test lead to multirange dc ammeter and record multifunction meter indication as V2.	
			c. Load regulation is difference between V1 and V2. Calculate this difference.	Equal to or less than 1.5 mV
5			a. Set multifunction meter LINE switch to off.	
			b. Observe dual-trace oscilloscope dis play and measure the ripple voltage and noise.	Equal to or less than 1 mV p
6			Set multifunction meter LINE switch to on.	
7			a. Adjust variable transformer for a 132 V ac indication on vom.	
			b. Record the multifunction meter indication as V3.	
8			a. Adjust variable transformer for 105 V ac indication on vom and record multifunction meter indication as V4.	
			b. Calculate line regulation as the difference between V3 and V4.	Equal to or less than 1.5 mV

Section XXXI. TESTING OF DUAL 15 V DC POWER SUPPLY HTA-9A1PS2

163. General. This section contains the procedures essary for performance testing dual 15 V dc power ply HTA-9A1PS2 after replacement of components owing the completion of troubleshooting or mainte-e procedures. Each of the preliminary procedures the performance test must be performed in the given ence. Preliminary procedures consist of obtaining the d test equipment, making prescribed test connections, initially setting equipment controls to the specified settings. These settings, and all subsequent settings given in the performance test table, must be made carefully to ensure accurate test conditions. If the test procedures result in the dual 15 V dc power supply meeting all performance standards specified in the performance test, the equipment can be returned to service.

3-164. Test Equipment and Materials. Table 3-43 lists the test equipment required for the performance test.

Table 3-43 Test Equipment Required for Dual 15 V DC Power Supply HTA-9A1PS2 Performance Test Procedure

Common neme	Part/model no.	Qty	Manufacturer
e Cord	17449-S	1	Belden
AC, 3-Wire to 2-Wire	785-0419	1	Allied
Banana Jack to Minigator Clip	3448	7	Pomona
Single Banana Plug to Binding Post	2894	2	Pomona
DC, Multirange	931-2902001	1	Weston Instruments
Multifunction	3450B	1	Hewlett-Packard
ter, Volt-Ohm- (VOM)	260-6	1	Simpson
e, Dual-Trace	475	1	Tektronix
Carbon Compression	82905	1	Central Scientific
Banana Plug to Alligator Clip	1166-36-B	1	Pomona
Banana Plug to Banana Plug	B-48(B)	3	Pomona
Banana Plug to Banana Plug	B-48(R)	2	Pomona
BNC Plug to Double Banana Plug (44″)	11001A	1	Hewlett-Packard
Spade Lug to Banana Plug	1370-24-B	1	Pomona
Spade Lug to Banana Plug	1370-24-R	1	Pomona
ade Lug to Spade Lug	1743-36-R	1	Pomona
Variable	3PN2210	1	Staco

t Connections and Conditions. e testing of dual 15 V dc power supply HTA- accomplished in a bench test setup. Prior to the performance test, prepare the equipment

m function switch to AC and range switch V. Connect vom to variable transformer output plug.

b. Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable power transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF. Disconnect vom.

c. Adjust carbon compression rheostat for maximum resistance (fully ccw).

d. Connect test equipment as shown in figure 3-42.

NOTE

Twist test leads on multifunction meter, rheostat and ammeter that connect to power supply to cancel external noise signals.

Initial test Equipment Settings. Initial test ment settings for the performance test are as fol-

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Oscilloscope	
POWER	On (pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe signal
CH1 AC-GND-DC	AC
HORIZ DISPLAY	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER - SLOPE AND LEVEL	As required for stable display
Variable transformer	
Power switch	ON

3-167. Performance Test Procedures. Table 3-44 contains the test procedure for dual 15 V dc power supply HTS-9A1PS2. Proceed sequentially through the table in accordance with the numbered steps. Set the test equipment controls and equipment under test controls as directed in the table and perform the prescribed test procedure. If the result is within specified performance standard limits, proceed to the next step in the table. If the result is not as specified, perform the troubleshooting procedure in paragraph 3-37, section VII of this chapter. After fault correction, repeat the performance test.

Table 3-44 Dual 15 V DC Power Supply HTA-9A1PS2 Performance Test Procedure

Control settings		Test procedure	Performance standard
Test equipment	Equipment under test		
As specified in paragraph 3-165.		Observe multirange dc ammeter and adjust carbon compression rheostat for value specified as performance standard.	0.5 A
		Disconnect test lead from positive post of multirange dc ammeter.	
		Adjust power supply VDC control to obtain specified output voltage indication on multifunction meter.	15 ± 0.15 V dc
		a. Record multifunction meter indication as V1.	
		b. Reconnect test lead to multirange dc ammeter and record multifunction meter indication as V2.	
		c. Load regulation is difference between V1 and V2. Calculate this difference.	equal to or less than 2.5 mV dc
		a. Set multifunction meter LINE switch to off.	
		b. Observe dual-trace oscilloscope	equal to or less

Table 3-44 Dual 15 V DC Power Supply HTA-9A1PS2 Performance Test Procedure - Continued

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
			display and measure the ripple voltage and noise.	than 1 mV p-p
6			Set multifunction meter LINE switch to on.	
7			a. Adjust variable transformer for a 132 V ac indication on vom. b. Record the multifunction meter indication as V3.	
8			a. Adjust variable transformer for 105 V ac indication on vom and record multifunction meter indication as V4. b. Calculate line regulation as the difference between V3 and V4.	equal to or less than 2.5 mV dc

SECTION XXXII. TESTING OF +15 V DC GATE POWER SUPPLY HTA-9A1PS3

3-168. General. This section contains the procedures necessary for performance testing +15 V dc gate power supply HTA-9A1PS3 after replacement of components following the completion of troubleshooting or maintenance procedures. Each preliminary procedure and performance test must be performed in the given sequence.

The preliminary procedure consists of obtaining the listed test equipment, making the prescribed test connection, and initially setting the equipment controls to the fied settings. These settings, and all subsequent given in the performance test table, must be made fully to ensure accurate test conditions. If the test dures result in the +15 V dc gate power supply all performance standards specified in the perform test, the equipment can be returned to service.

3-169. Test Equipment and Materials. Table lists the test equipment required for the performance

Table 3-45 Test Equipment Required for 15 V DC Gate Power Supply HTA-9A1PS3 Performance Test Procedure

Common name	Part/model no.	Qty	Manufacturer
AC Line Cord	17449-S	1	Belden
Adapter, AC, 3-Wire to 2-Wire	785-0419	1	Allied
Adapter, Banana Jack to Minigator Clip	3448	7	Pomona
Adapter, Single Banana Plug to Binding Post	2894	2	Pomona
Ammeter, DC, Multirange	931-2902001	1	Weston Instruments
Meter, Multifunction	3450B	1	Hewlett-Packard

best copy available

pages tightly bound

Table 3-45 Test Equipment Required for 15 V DC Gate Power Supply HTA-9A1PS3 Performance Test Procedure - Continued

Common name	Part/model no.	Qty	Manufacturer
meter, Volt-Ohm- (VOM)	260-6	1	Simpson
scope, Dual-Trace	475	1	Tektronix
stat, Carbon Compression	82905	1	Central Scientific
Lead, Banana Plug to Alligator Clip	1166-36-B	1	Pomona
Lead, Banana Plug to Banana Plug	B-48(B)	3	Pomona
Lead, Banana Plug to Banana Plug	B-48(R)	2	Pomona
Lead, BNC Plug to Double Banana	11001A	1	Hewlett-Packard
Lead, Spade Lug to Banana Plug	1370-24-B	1	Pomona
Lead, Spade Lug to Banana Plug	1370-24-R	1	Pomona
Lead, Spade Lug to Spade Lug	1743-36-R	1	Pomona
former, Variable	3PN2210	1	Staco

0. Test Connections and Conditions. rmance testing of +15 V dc gate power supply A-9A1PS3 is accomplished in a bench test setup. r to performing the performance test, prepare the ment as described below.

a. Set vom function switch to AC and range switch to 250 V. Connect vom to variable transformer output plug.

b. Connect variable transformer to power source. Set power switch to ON and observe that indicator lights. Adjust variable power transformer for 115 V ac indication on vom. Set variable transformer power switch to OFF.

c. Adjust carbon compression rheostat for maximum resistance (fully ccw).

d. Connect test equipment as shown in figure 3-37.

NOTE

Twist test leads on multifunction meter, rheostat and ammeter that connect to power supply to cancel external noise signals.

1. Initial Test Equipment Settings. Initial test ment settings for the performance test are as fol-

Control	Position
Multifunction meter	
LINE	On (up)
FUNCTION	DC
RANGE	AUTO
CONTROL	LOCAL
TRIGGER	INT
Oscilloscope	
POWER	On (pull)
VERT MODE	CH1
CH1 VOLTS/DIV	As required to observe signal
CH1 AC-GND-DC	AC
HORIZ DISPLAY	A
TRIG MODE	NORMAL
COUPLING	AC
SOURCE	NORM
TIME/DIV	As required to observe signal
A TRIGGER - SLOPE and LEVEL	As required for stable display

Control	Position
Oscilloscope	
Variable transformer	
Power switch	ON

3-172. Performance Test Procedures. Table 3-46 contains the test procedure for +15 V dc gate power supply HTA-9A1PS3. Proceed sequentially throug table in accordance with numbered steps. Set test equ ment controls and equipment under test controls a rected in the table and perform the prescribed procedure. If the result is within specified perform standard limits, proceed to the next step in the table the result is not as specified, perform the troubleshoo procedure in paragraph 3-38, section VII of this chap After fault correction, repeat the performance test.

Table 3-46 15 V DC Gate Power Supply HTA-9A1PS3 Performance Test Procedure

Step no.	Control settings		Test procedure	Performance standa
	Test equipment	Equipment under test		
1	As specified in paragraph 3-17.		Observe multirange dc ammeter and adjust carbon compression rheostat for value specified as performance standard.	3.2 A
2			Disconnect test lead from positive post of multirange dc ammeter.	
3			Adjust power supply VDC control to obtain specified output voltage indication on multifunction meter.	15 ±0.75 V dc
4			a. Record multifunction meter indication as V1.	
			b. Reconnect test lead to multirange dc ammeter and record multifunction meter indication as V2.	
			c. Load regulation is difference between V1 and V2. Calculate this difference.	Equal to or less than 2.5 mV
5			a. Set multifunction meter line switch to off.	
			b. Observe dual-trace oscilloscope dis play and measure the ripple voltage and noise.	Equal to or less than 1 mV p
6			Set multifunction meter line switch to on.	
7			a. Adjust variable transformer for a 132 V ac indication on vom.	
			b. Record the multifunction meter indication as V3.	
8			a. Adjust variable transformer for 105 V ac indication on vom and record multifunction meter reading as V4.	
			b. Calculate line regulation as the difference between V3 and V4.	Equal to or less than 2.5 mV

SECTION XXXIII. TESTING OF ANTENNA ANCILLARY GROUP HTA-12

3. **General.** Antenna ancillary group HTA-12 is performance tested after replacement or repair of of the four antenna drive assemblies A1 through A4, ving the completion of troubleshooting procedures ribed in section VIII and/or maintenance procedures ibed in section XVI. After replacement of an anten- ive assembly or major subassembly, the assembly is ected in the operational configuration and tested as part of the servo and control equipment group (section XIX).

3-174. Subassembly Performance Testing. The antenna ancillary group HTA-12 subassemblies, such as tachometer-generator G1, electric disk brake A1, dc drive motor B1, and motor blower B2, are performance tested at a higher level of maintenance after repair.

Section XXXIV. TESTING OF AZIMUTH AND ELEVATION DATA MODULES HTA-8A7A1 AND HTA-6A6A1

5. **General.** Azimuth data module HTA-8A7A1 vation data module HTA-6A6A1 is to be perform- tested after replacement of integral assemblies or semblies following the completion of troubleshoot- procedures described in section IX and/or mainte- procedures described in section XVII. After replacement of component parts, the azimuth or elevation data module is tested as part of the servo and control equipment group (section XIX).

3-176. Subassembly Performance Testing. Data module subassemblies are not repairable and are factory tested for performance.

SECTION XXXV. TESTING OF ANTENNA SAFETY INTERLOCK GROUP

General. The antenna safety interlock group ts of two interlock circuits. (See figure 2-10).) Per- nce testing of either circuit is accomplished as part servo and control equipment group (section XIX). mance testing of the safety interlock group is re- when any unit has been repaired or replaced following performance of the troubleshooting procedures described in section X and/or the maintenance procedures described in section XVIII.

3-178. Subassembly Performance Testing. Subassemblies of the antenna safety interlock group are not repairable and are factory tested for performance.

CHAPTER 4

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

SECTION I. GENERAL

Scope. This chapter provides the maintenance ructions for instrument servo assembly 14A8A1, A2. Section I specifies tools and materials required for intenance. Section II contains the information red to replace and align synchro B2 or B3, and to replace and test servo motor B1 and clutch L1.

4-2. Tools and Materials. Table 4-1 lists tools and materials required to perform maintenance on instrument servo assembly 14A8A1, A8A2.

Table 4-1 Tools and Test Equipment Required for Maintenance

Common name	Official nomenclature	Part/model no.Qty		Manufacturer
Line Cord		17449-S	2	Belden
er, Banana Jack to Size 20 Female Connector		3560	11	Pomona
er, Single Banana Plug to Binding Post		2894	5	Pomona
meter, Volt-Ohm- (VOM)	Multimeter ME-450/U	260-6	1	Simpson
r Supply, 0-80/0-40 V	Power Supply PP-7208/U	LPD-422A-FM	1	Lambda
Lead, Banana Plug to Banana Plug		B-12	5	Pomona
Lead, Banana Plug to Banana Plug		B-48(B)	2	Pomona
		B-48(R)	2	Pomona
Lead, Banana Plug to Banana Plug		B-48(R)	2	Pomona
Lead, Microgator Clip to Microgator p		1613-12	1	Pomona
former, Variable		3PN2210	1	Staco

SECTION II. MAINTENANCE OF INSTRUMENT SERVO ASSEMBLIES 14A8A1 AND 14A8A2

4-3. Instrument Servo Assembly Synchro 14A8A1B2,B3 or 14A8A2B2,B3 Removal and Replacement (fig. 3-5, 4-1).

a. Hand set counter readout to 000.0 (fig. 3-5, sh 2).

b. Remove four phillips-head screws holding cover to rear plate and pull chassis from cover (fig. 3-5, sh 1).

c. Remove four screws and lockwashers holding rear plate to support and support posts (fig. 3-5, sh 1). Bend wires and hold rear plate away to expose synchros (fig. 4-1).

d. To remove B3 only, loosen two screws holding support to component plate (fig. 3-5, sh 3). Tip support to one side sufficiently to allow removal of synchro B3 (fig. 4-1).

e. Tag and disconnect five wires from synchro to be removed.

f. Loosen allen-head screw on synchro shaft clamp.

NOTE

It may be necessary to rotate shaft to gain access to allen-head screw.

g. Loosen three clamp screws at base of synchro (fig 4-1). Turn three clamps so that flat edges are toward synchro body.

h. Remove synchro from component plate.

i. Insert replacement synchro into position. Turn three clamps, round edge to synchro body, and tighten clamp screws finger tight.

j. Identify and connect five wires to synchro terminals.

k. To replace B3 only, tighten two screws to secure support to component plate (fig. 3-5, sh 3).

l. Position rear plate on support and support posts (fig 4-1) and secure with four screws (fig. 3-5, sh 1).

m. Perform synchro alignment procedure (para 4-4).

n. Tighten clamp screws on replaced synchro (fig. 4-1).

o. Slide chassis into cover with counter facing forward (fig. 3-5, sh 2).

p. Secure rear plate to cover with four screws (fig. 3-5, sh 1).

4-4. Instrument Servo Assembly Clutch 14A8A1L1, A2L1 Removal and Replacement (fig. 3-5, 4-1).

a. Hand set counter readout to 000.0 (fig. 3-5, sh 2).

b. Remove four phillips-head screws securing cover to rear plate and pull chassis from cover (fig. 3-5, sh 1).

c. Remove four screws and lockwashers holdi
plate to support and support posts. Bend wi
fold rear plate away to expose synchros B2
and clutch L1 (fig. 4-1).

d. Support outer gear on clutch shaft (with a V
or other device) and carefully tap out tap
from clutch shaft.

e. Remove three screws and lockwashers se
relay K1 mounting bracket to chassis (fig. 3
3). Carefully lift mounting bracket from
gear compartment.

f. Remove four screws and lockwashers securi
spacer plate to inner gear mounting plate
component plate.

g. Remove top support post retaining screw
screw securing chassis mounting bracket (i
fied on fig. 3-5, sh 2). Pivot top spacer pl
on pivot pins (fig. 3-5, sh 3) to gain acc
allen-head screws on synchro couplers inside
gear compartment.

h. Loosen screw securing each synchro coup
sembly to synchro shaft.

i. Remove two screws and lockwashers securi
ner gear mounting plate to bottom spacer
Carefully lift inner gear mounting plate an
ched parts from inner gear compartment. Li
er gear from clutch shaft.

j. Remove three screws and lockwashers from
gear and remove gear from clutch L1.

k. Remove three screws and washers holding
to component plate and remove clutch fr
sembly.

l. Tag and unsolder wires to clutch.

m. Install replacement clutch on componen
and secure with three screws and washers

n. Carefully install inner gear on clutch and
gear to clutch with three screws and lock

o. Install outer gear on clutch shaft. Suppor
shaft in a V-block or other device and
7/16-inch by 7/0-inch taper pin in shaft
tap into place.

p. Place main assembly on work surface with
bly resting on support and support posts.

q. Carefully install inner gear mounting p
attached components into inner gear c
ment while meshing gears and shafts.

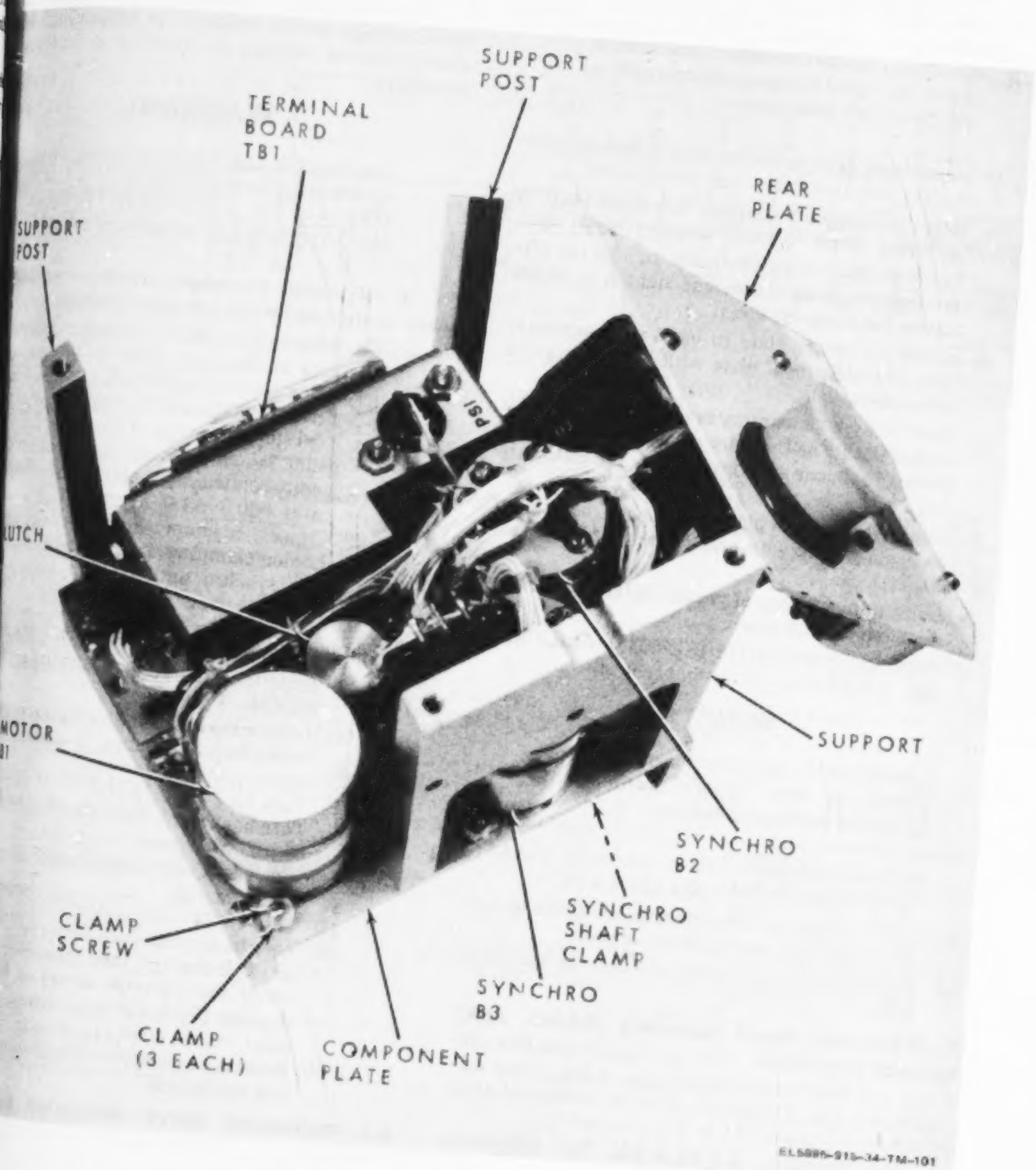

SUPPORT POST
TERMINAL BOARD TB1
SUPPORT POST
REAR PLATE
PS1
LUTCH
SUPPORT
MOTOR
1
SYNCHRO B2
SYNCHRO SHAFT CLAMP
CLAMP SCREW
SYNCHRO B3
CLAMP (3 EACH)
COMPONENT PLATE
EL5895-915-34-TM-101

Figure 4-1. Instrument servo assembly 14A8A1, A8A2, parts location.

NOTE

Antibacklash gear in inner gear compartment must be loaded (THREE-FIVE teeth) while engaging antibacklash gear with digital readout drive gear, which must also be positioned to engage digital readout and drive shaft bevel gears.

r. Secure inner gear mounting plate to bottom spacer plate with two screws and lockwashers.

s. Secure both synchro couplers to synchro shaft by tightening screw in each coupler finger tight.

t. Pivot top spacer plate into place, tighten top support post retaining screw, and tighten to secure chassis mounting bracket.

u. Secure top spacer plate to inner gear mounting plate and component plate with four screws and lockwashers.

v. Insert relay K1 mounting bracket into inner gear compartment and secure relay K1 mounting bracket to chassis with three screws and lockwashers.

w. Fold rear plate into place on support and support posts and secure with four screws and lockwashers.

x. Apply a thin coating of grease (MIL-G-23827) to the teeth of each gear.

y. Apply one drop of oil (MIL-L-6085) to each bearing.

NOTE

Lubrication of rotary components is not required, as they contain permanently lubricated and sealed bearings.

z. Perform instrument servo assembly 14A8A1, A8A2 alignment procedure (para 4-5).

aa. Install chassis in cover and secure cover to rear plate with four phillips-head screws.

ab. Perform instrument servo performance test (para 4-7).

4-5. Instrument Servo Assembly 14A8A1, A8A2 Alignment Procedure. This paragraph provides preliminary and alignment procedures for an instrument servo assembly. The procedures are to be performed after replacement of synchro B2 or B3, or clutch L1.

a. Test Equipment and Materials. Test equipment and materials required for alignment are listed in table 4-1.

b. Test Connections and Conditions. The alignment procedure is performed in a bench setup as shown in figure 4-2. Before connecting variable transformer and power supply, adjust variable transformer for 64 V output using vom, and adjust power supply for +24 V output. Turn power supply and variable transformer after setup.

c. Initial Control Settings. The initial test ment settings are as specified in subparagraph above. Counter settings are specified in the procedure.

WARNING

Use extreme care when tightening clamp screws and adjusting synchros. 120 V ac is exposed on pins A and B of J1, FL1 output pins 3 and 4, and T2 primary pins 4 and 5.

d. Alignment Procedure. Perform the steps to align an instrument servo assembly.

(1) Turn on ac power at variable transformer plug ac line cord 17449-S into an ac Allow counter to drive until it stops. If drives to 000.0 ±0.02 degrees, proceed next step. If counter stops driving at any point, loosen three clamps on synchro gently rotate synchro body until counter cates 000.0 ±1.0 degrees. Tighten

(2) Connect a jumper across R3 (see fig. Loosen clamps on synchro B3 and gently tate synchro until counter indicates ±0.02 degrees. Tighten clamps.

(3) Remove jumper from R3. Loosen synchro B2 and gently rotate synchro again indicates 000.0 ±0.02 degrees. clamps.

(4) Jumper R3 again and verify that counter cation does not change. If indication repeat steps (2) and (3).

(5) Turn on 24 V dc power.

(6) Turn handcrank shaft for a counter of 10.00 degrees, then turn off dc supply and verify that counter drives ±0.02 degrees.

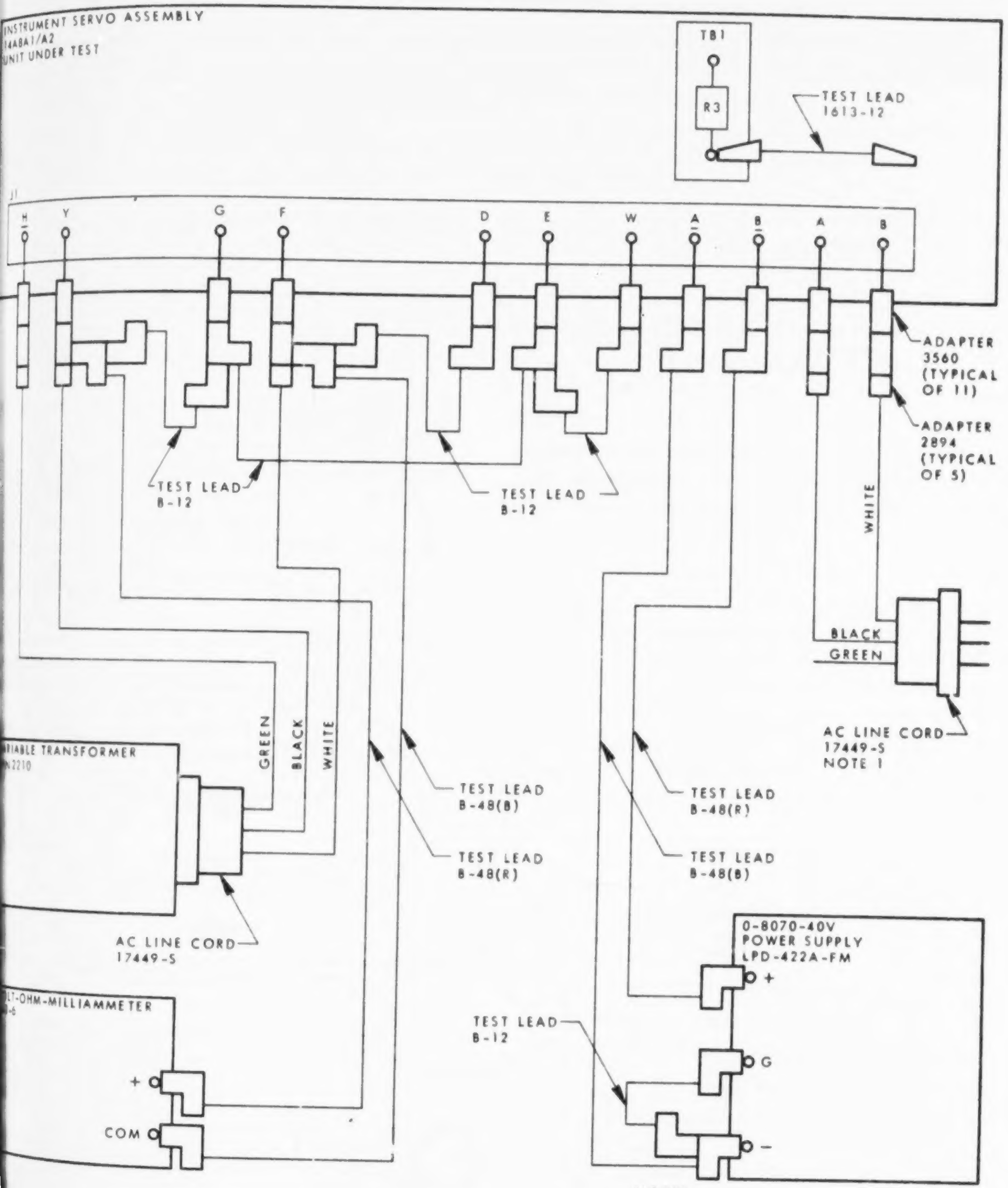
(7) Turn on 24 V dc power.

(8) Turn handcrank shaft for a counter of 180.0 degrees, then turn off dc power verify that counter drives to 000.0 degrees. If counter stops driving at any point, repeat steps (1) through (6).

(9) Remove any jumpers installed and test equipment.

4-6. Instrument Servo Assembly Servo 14A8A1B1 or A8A2B1 Removal and (fig. 3-5, 4-1). Perform the following steps and replace servo motor B1.

a. Remove four screws holding the cover plate and pull chassis from cover (fig.

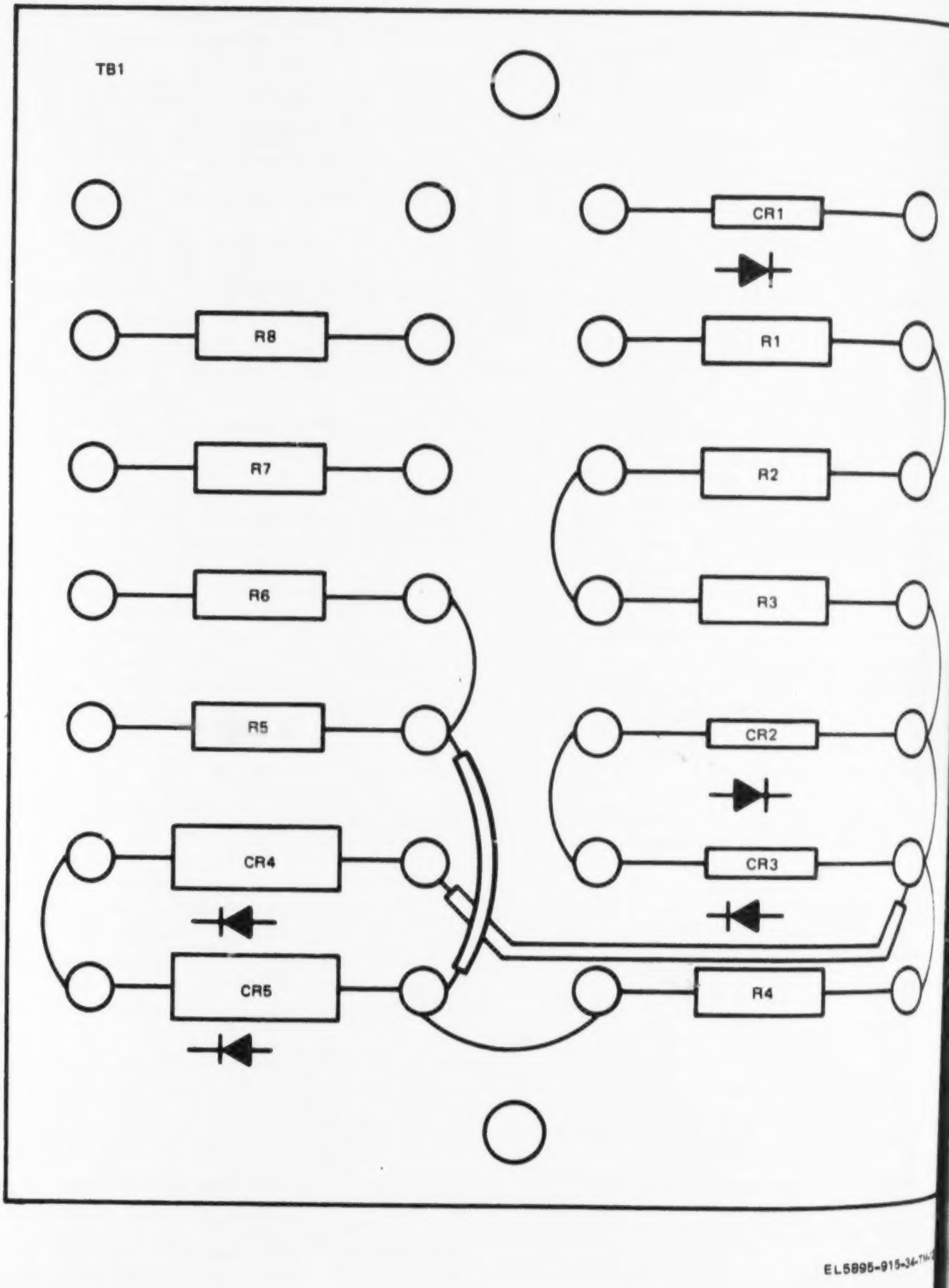

NSTRUMENT SERVO ASSEMBLY
4A8A1/A2
NIT UNDER TEST
TB1
R3
TEST LEAD
1613-12
J1
H
Y
G
F
D
E
W
A
B
A
B
ADAPTER
3560
(TYPICAL
OF 11)
ADAPTER
2894
(TYPICAL
OF 5)
TEST LEAD
B-12
TEST LEAD
B-12
WHITE
BLACK
GREEN
AC LINE CORD
17449-S
NOTE 1
GREEN
BLACK
WHITE
IABLE TRANSFORMER
N2210
TEST LEAD
B-48(B)
TEST LEAD
B-48(R)
TEST LEAD
B-48(R)
TEST LEAD
B-48(B)
AC LINE CORD
17449-S
LT-OHM-MILLIAMMETER
-6
+
COM
0-8070-40V
POWER SUPPLY
LPD-422A-FM
+
G
−
TEST LEAD
B-12

NOTES:

1. TAPE BACK GREEN WIRES.
2. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.

EL5895-915-34-TM-102

Figure 4-2. Instrument servo assembly 14A8A1, A8A2 alignment, test setup diagram.


TB1
CR1
R8
R1
R7
R2
R6
R3
R5
CR2
CR4
CR3
CR5
R4

EL5895-915-34-

Figure 4-3. Instrument servo assembly terminal board 14A8A1TB1, A8A2TB1, parts location.

b. Remove four screws holding rear plate to support and support posts. Bend wires and rear plate away to expose servo motor (fig. 4-1).

c. Cut wire tie-down and identify and tag five leads. Cut all five servo motor leads.

d. Loosen three clamp screws at base of servo motor. Turn clamps so that flat edges are toward servo motor body.

e. Remove servo motor from component plate.

f. Insert replacement servo motor into position, properly meshing the gears.

g. Turn clamps so that round edges are toward servo motor body and tighten three clamp screws finger tight.

h. Identify and connect five wires to servo motor leads.

i. Position rear plate on support and support posts (fig. 4-1) and secure with four screws (fig. 3-5, sh 1.)

m. Perform instrument servo performance test procedure (para 4-7).

n. Tighten clamp screws (fig. 4-1).

o. Slide chassis into cover with counter facing forward (fig. 3-5, sh 2).

p. Secure rear plate to cover with four screws (fig. 3-5, sh 1).

4-7. Instrument Servo Assembly 14A8A1B1, A2B1 Performance Test Procedure. This paragraph provides instructions for performance testing an instrument servo assembly and should be performed after replacement of servo motor B1, synchro B2 or B3, or clutch L1.

a. Test Equipment and Materials. Test equipment and materials required for testing instrument servo assembly 14A8A1, A8A2 are listed in table 4-1.

b. Test Connections and Conditions. The test procedure is performed in a bench test setup as shown in figure 4-2. Connect equipment as follows.

(1) Using vom, adjust up variable transformer for 64 V rms output, then disconnect ac input to transformer.

(2) Using power supply local controls and indicators, adjust power supply for 24 V dc output, then disconnect ac input to power supply.

(3) Connect equipment as shown in figure 4-2, except do not connect ac inputs to variable transformer or power supply.

c. Initial Control Settings. Initial test equipment settings are as specified in subparagraph 4-7*b* above. Counter settings are specified in the test procedure.

d. Test Procedure. Perform the following steps to verify performance of instrument servo assembly 14A8A1B1, A8A2B1.

(1) Connect ac power to variable transformer and allow counter to drive until it stops.

(2) Connect ac power to power supply input.

(3) Turn counter to 10 degrees, then disconnect ac input to power supply. Verify that counter drives toward 0 degrees. If counter does not drive, servo motor is defective or wires were incorrectly connected.

(4) Disconnect test equipment.

APPENDIX

REFERENCES

The following is a list of applicable references that are available to the repairman of Servo and Control Equipment.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies, and Equipment Used by the Army.
SC 5180-91-CL-RO7	Tool Kit Electronics Equipment TK-105/G.
SM 11-4-5180-SO5	Tool Equipment TE-50B.
TB 291	Safety Measures to be Observed When Installing and Using Whip Antennas, Field Type Masts, Towers, Antennas, and Metal Poles That are Used with Communication, Radar, and Direction Finder Equipment (TO 31P5-1-1).
TB 746-10	Field Instructions for: Painting and Preserving Electronics Command Equipment.
TM 9-213	Painting Instructions for Field Use.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Material to Prevent Enemy Use (Electronics Command).
TM 5-4120-343-14	MOAC 336 Air Conditioner, Operation and Service Manual.
TM 5-4120-343-24P	MOAC 336 Air Conditioner, Repair Parts Manual.
TM 11-5895-898-12 NAVELEX 0967-LP-546-6010 TO 31R5-2FSC78-1	Operator and Organizational Maintenance Manual for Satellite Communication Terminal AN/FSC-78(V).
TM 11-5895-898-20P NAVELEX 0967-LP-546-6020 TO 31R5-2FSC78-4	Organizational Maintenance Repair Parts, and Special Tools List for Satellite Communication Terminal AN/FSC-78(V).
TM 11-5895-899-12 NAVELEX 0967-LP-546-5010 TO 31R5-2FSC79-1	Operator and Organizational Maintenance Manual for Satellite Communication Terminal AN/FSC-79.
TM 11-5895-899-20P NAVELEX 0967-LP-546-5020 TO 31R5-2FSC79-4	Organizational Maintenance Repair Parts, and Special Tools List for Satellite Communication Terminal AN/FSC-79.
TM 11-5895-900-34 NAVELEX 0967-LP-546-6030 TO 31R5-2-102	Direct and General Support Maintenance Manual for Antenna and Microwave Equipment including: Feed Assembly AS-2941/FSC; Feed Assembly AS-2941A/FSC; Dehumidifier, Desiccant, Electric HD-988/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.

TM 11-5895-900-34P NAVELEX 0967-LP-546-6040 TO 31R5-2-104	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Antenna and Microwave Equipment including: Feed Asse bly AS-2941/FSC; Dehumidifier, Desiccant, Electric HD-988/G Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-
TM 11-5895-901-34 NAVELEX 0967-LP-546-6060 TO 31R5-2G-112	Direct and General Support Maintenance Manual for Up- and Do Converter Racks including: Rack, Electrical Equipment MT-477 Rack, Electrical Equipment MT-4774/G for Satellite Communica Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-901-34P NAVELEX 0967-LP-546-6070 TO 31R5-2G-114	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Up- and Down-Converter Racks including: Rack, Elec Equipment MT-4773/G; Rack, Electrical Equipment MT-4774/G Satellite Communication Terminals AN/FSC-78(V) and AN/FSC
TM 11-5895-902-34 NAVELEX 0967-LP-546-6090 TO 31R5-2G-122	Direct and General Support Maintenance Manual for Tracking Rece Equipment including: Scanner, Signal TD-1104/GSC; Power Su PP-6976/G; Converter, Frequency, Electronic CV-3131/G; Demo lator MD-922/G; Control-Indicator ID-1911/G for Satellite Comm cation Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-902-34P NAVELEX 0967-LP-546-6100 TO 31R5-2G-124	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Tracking Receiver Equipment including: Scanner, Sig TD-1104/GSC; Power Supply PP-6976/G; Converter, Freque Electronic CV-3131/G; Demodulator MD-922/G; Control-Indica ID-1911/G for Satellite Communication Terminals AN/FSC-78(V) AN/FSC-79.
TM 11-5895-903-34 NAVELEX 0967-LP-546-6120 TO 31R5-2G-132	Direct and General Support Maintenance Manual for Parametric plifier Group OG-133/G for Satellite Communication Terminal FSC-78(V).
TM 11-5895-903-34P NAVELEX 0967-LP-546-6130 TO 31R5-2G-134	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Parametric Amplifier Group OG-133/G for Satellite C munication Terminal AN/FSC-78(V).
TM 11-5895-904-34 NAVELEX 0967-LP-546-6150 TO 31R5-2G-142	Direct and General Support Maintenance Manual for Interfacility L Amplifier Equipment including: Amplifier, Radio Frequency AM-6 G; Amplifier, Radio Frequency AM-6629/G; Amplifier, Radio F quency AM-6644/G; Amplifier, Radio Frequency AM-6788/FSC Control-Monitor C-9400/G; Amplifier-Monitor OG-150/G for Sate Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-904-34P NAVELEX 0967-LP-546-6160 TO 31R5-2G-144	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Interfacility Link Amplifier including: Amplifier, Radio F quency AM-6628/G; Amplifier, Radio Frequency AM-6629/G; Am fier, Radio Frequency AM-6644/G; Amplifier, Radio Frequency 6788/FSC-79; Control-Monitor C-9400/G; Amplifier, Monitor Gr OG-150/G for Satellite Communication Terminals AN/FSC-78(V) AN/FSC-79.

TM 11-5895-905-34 NAVELEX 0967-LP-546-6180 TO 31R5-2G-152	Direct and General Support Maintenance Manual for Frequency Generation Equipment including: Generator Group, Signal OV-64/G; Amplifier Group OG-151/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-905-34P NAVELEX 0967-LP-546-6190 TO 31R5-2G-154	Direct Support, General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Frequency Generation Equipment including: Generator Group, Signal OV-64/G; Amplifier Group OG-151/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-906-34 NAVELEX 0967-LP-546-6210 TO 31R5-2-112	Direct and General Support Maintenance Manual for Radio Frequency Amplifier Equipment including: Amplifier, Radio Frequency OG-131A/MSC; Amplifier, Radio Frequency OG-132A/MSC; Cooler, Liquid, Electron Tube HD-955A/GR for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-906-34P NAVELEX 0967-LP-546-6220 TO 31R5-2-114	Direct Support, General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Radio Frequency Amplifier Equipment including: Amplifier, Radio Frequency OG-131A/MSC; Amplifier, Radio Frequency OG-132A/MSC; Cooler, Liquid, Electron Tube HD-955A/GR for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-907-34 NAVELEX 0967-LP-546-6240 TO 31R5-2G-162	Direct and General Support Maintenance Manual for Status and Alarm Equipment including: Power Supply Assembly PP-6958/G; Control-Monitor C-9861/G; Control-Monitor C-9854/G; Indicator, Channel Frequency ID-2030/G; Control-Indicator ID-2028/G; Control-Indicator ID-2033/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-907-34P NAVELEX 0967-LP-546-6250 TO 31R5-2G-164	Direct Support, General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Status and Alarm Equipment including: Power Supply Assembly PP-6958/G; Control-Monitor C-9861/G; Control-Monitor C-9854/G; Indicator, Channel Frequency ID-2030/G; Control-Indicator ID-2028/G; Control-Indicator ID-2033/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-908-34 NAVELEX 0967-LP-546-6270 TO 31R5-2G-172	Direct and General Support Maintenance Manual for Radio Frequency Monitor and Test Group including: Interconnecting Group ON-148/G; Interconnecting Group ON-149/G; Amplifier Assembly AM-6625/G; Monitor Test Group OA-8836/G; Control-Indicator C-9404/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-908-34P NAVELEX 0967-LP-546-6280 TO 31R5-2G-174	Direct Support, General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Radio Frequency Monitor and Test Group including: Interconnecting Group ON-148/G; Interconnecting Group ON-149/G; Amplifier Assembly AM-6625/G; Monitor Test Group OA 8836/G; Control Indicator C-9404/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79.

TM 11-5895-909-34 NAVELEX 0967-LP-546-6300 TO 31R5-2G-182	Direct and General Support Maintenance Manual for Receiver (Monitor Equipment including: Monitor, Radio Frequency ID-193 Monitor, Pilot Carriers ID-1916/G for Satellite Communication Te nal AN/FSC-78(V).
TM 11-5895-909-34P NAVELEX 0967-LP-546-6310 TO 31R5-2G-184	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Receiver Gain Monitor Equipment including: Monitor, Ra Frequency ID-1935/G; Monitor, Pilot Carriers ID-1916/G for Satell Communication Terminal AN/FSC-78(V).
TM 11-5895-910-34 NAVELEX 0967-LP-546-6330 TO 31R5-2G-192	Direct and General Support Maintenance Manual for Receiver Ra Frequency Noise Measurement Equipment including: Test Set, Ra Frequency Noise TS-3376/G; Monitor, Noise Temperature ID-1915 for Satellite Communication Terminal AN/FSC-78(V).
TM 11-5895-910-34P NAVELEX 0967-LP-546-6340 TO 31R5-2G-194	Direct Support, General Support Maintenance Repair Parts and Sp cial Tools List (Including Depot Maintenance Repair Parts and Spec Tools) for Receiver Radio Frequency Noise Measurement Equipme including: Test Set, Radio Frequency Noise TS-3376/G; Monito Noise Temperature ID-1915/G for Satellite Communication Termi AN/FSC-78(V).
TM 11-5895-911-34 NAVELEX 0967-LP-546-6360 TO 31R5-2G-202	Direct and General Support Maintenance Manual for Carrier Le Control and Monitor Equipment including: Control-Monitor Gro OK-299/G; Control-Monitor C-9851/G; Power Supply Assembly P 6960/G; Detector, Radio Frequency CV-3288/G for Satellite Comm nication Terminals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-911-34P NAVELEX 0967-LP-546-6370 TO 31R5-2G-204	Direct Support, General Support Maintenance Repair Parts and Sp cial Tools List (Including Depot Maintenance Repair Parts and Spec Tools) for Carrier Level Control and Monitor Equipment includi Control-Monitor Group OK-299/G; Control-Monitor C-9851/G; Pow Supply Assembly PP-6960/G; Detector, Radio Frequency CV-328 for Satellite Communication Terminals AN/FSC-78(V) and A FSC-79.
TM 11-5895-912-34 NAVELEX 0967-LP-546-6390 TO 31R5-2G-212	Direct and General Support Maintenance Manual for Transmi Power Monitor Equipment including: Monitor, Radio Frequency M 9472/G; Control-Indicator C-9841/G for Satellite Communication T minals AN/FSC-78(V) and AN/FSC-79.
TM 11-5895-912-34P NAVELEX 0967-LP-546-6400 TO 31R5-2G-214	Direct Support, General Support Maintenance Repair Parts and S cial Tools Listing (Including Depot Maintenance Repair Parts a Special Tools) for Transmitter Power Monitor Equipment includi Monitor, Radio Frequency MX-9472/G; Control-Indicator C-984 for Satellite Communication Terminals AN/FSC-78(V) and A FSC-79.
TM 11-5895-913-34 NAVELEX 0967-LP-546-6420 TO 31R5-2G-222	Direct and General Support Maintenance Manual for Translator, Sig Data CV-3098/G for Satellite Communication Terminal AN/FSC-78
TM 11-5895-913-34P NAVELEX 0967-LP-546-6430 TO 31R5-2G-224	Direct Support, General Support Maintenance Repair Parts and S cial Tools List (Including Depot Maintenance Repair Parts and Spe Tools) for Translator, Signal Data CV-3098/G for Satellite Commu ation Terminal AN/FSC-78(V).

11-5895-914-34	Direct Support and General Support Maintenance Manual: Ancillary Equipment Including: Control Monitor ID-1914/G (NSN 5895-00-279-8483) for Satellite Communication Terminals AN/FSC-78 (V) and AN/FSC-79 (NAVELEX 0967-LP-546-6450; TO 31R5-2G-232).
11-5895-914-34P	Direct Support and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Ancillary Equipment Including: Control-Monitor ID-1914/G for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79 (NAVELEX 0967-LP-546-6460; TO 31R5-2G-234).
11-5895-915-34P	Direct Support and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Servo and Control Equipment Including: Control, Antenna C-9402/G (5895-00-257-6168); Indicator, Antenna, Position-Status ID-1912/G (5895-00-251-8071); Power Supply Assembly PP-6959/G (5895-00-251-8106); Control, Direct Current C-9849/GSC (5895-01-020-2825); Drive Assembly, Electro-mechanical, Antenna TG-232/FSC (5895-01-007-9402); Synchro, Antenna SN-498/FSC (5990-01-007-9483) and SN-482/FSC (5895-00-237-2453); Control-Indicator ID-1936/G (5895-00-241-9369) for Satellite Communication Terminals AN/FSC-78(V) and AN/FSC-79 (NAVELEX 0967-LP-546-6490; TO 31R5-2-124).
11-5895-1043-12	Operator's and Organizational Maintenance Manual for Satellite Communication Terminal AN/GSC-39(V)2 (NSN 5895-01-077-6249) (NAVELEX 0967-LP-625-3010; TO 31R5-2GSC39-11).
11-5895-1043-20P	Organizational Maintenance Repair Parts and Special Tool List for Satellite Communication Terminal AN/GSC-39(V)2 (NSN 5895-01-077-6249) (NAVELEX 0967-LP-625-3020; TO 31R5-2GSC39-14).
11-5895-0150-12	Operator's and Organizational Maintenance Manual: Satellite Communication Terminal AN/GSC-39(V)1 (NSN 5895-01-070-5685) (NAVELEX 0967-LP-643-9010; TO 31R5-2GSC39-1).
11-5895-1050-20P	Organizational Maintenance Repair Parts and Special Tools List for Satellite Communications Terminal, AN/GSC-39(V)1 (NSN 5895-01-070-5685) (NAVELEX 0967-LP-643-9020; TO 31R5-2GSC39-4).

GLOSSARY

A

ACQ	Acquisition. The condition in which tracking equipment is locked to the satellite beacon and the antenna is following satellite movement.
AFSCF	Air Force Satellite Control Facility. The DOD element satellite programs that include tracking, monitoring and commanding satellites.
ALC	Automatic Level Control.
ANGLE MODULATION	The modulation process in which the angle of a sine wave carrier is varied from the normal value.

B

BASEBAND	The composite information signal modulated on a chosen carrier.
ITE	Built In Test Equipment. The test equipment in the operating equipment rack for ongoing monitoring and test use.

C

CHANNEL	In electronic communication, a channel is: *a.* A path for transmitting electric signals, usually in distinction from other parallel paths, not necessarily a pair of metallic conductors. *b.* The number of independent channels on a system (or trunk) is measured by the number of separate communications facilities that it can provide. *c.* The smallest subdivision of a trunk by which a single type of communications service is provided, i.e., voice channel, teletypewriter channel, or data channel.
IRCUIT	The complete electrical path over which telecommunications are provided between end terminal instruments comprising send and receive channels.
MA	Control Monitor and Alarm. The equipment that provides alarm circuits and controls signal paths throughout the AN/FSC-78(V) and AN/FSC-79.

D

CA	Defense Communications Agency. The cognizant DOD agency responsible for exercising operational control over DOD communication service.
OD	Department of Defense.
CS	Defense Satellite Communications System. The elements of the defense communications system which support: *a.* Requirements of the worldwide military command and control system. *b.* Establishing, extending, and upgrading communications in direct support of combat forces. *c.* Communications requirements resulting from changes in deployment and mission of forces. *d.* Long-distance trunking networks.

E

R	Elevated Equipment Room. The enclosure located at the elevation yoke that houses the rf plate and associated equipment.

ERP	Effective Radiated Power. The power radiated from the antenna, that i antenna power input multiplied by the gain of the antenna.

F

FB	Fleet Broadcast. The operating portion of the Navy fleet satellite pro that provides simplex transmit functions to selected naval sea and air fo
FET	Field Effect Transistor. A semiconductor in which the resistance betw two terminals, the source and the drain, depend upon a field produced voltage applied to the third terminal, the gate.
FPA	Final Power Amplifier. The final stage of amplification in the uplink traveling wave tube (TWT) for the AN/FSC-78(V) and a klystron for the AN/FSC-79.
FULL-DUPLEX OPERATION	A type of operation in which simultaneous two-way conversations, messa or information may be passed between two or more points.

H

HALF-DUPLEX OPERATION	A circuit in which signals are transmitted alternately in either directi usually because of limitations of the terminal equipment.

I

IC	Integrated Circuit. A combination of interconnected circuit elements with a continuous substrate.
IF	Intermediate Frequency. The 70 or 700 MHz baseband signal utilized satellite communications systems.
IFLA	Interfacility Link Amplifier. A solid state amplifier which provides pow gain to overcome cable and interconnect losses between major equipme elements within the AN/FSC-78(V) terminal.
ISOTROPIC RADIATOR	A hypothetical antenna radiating or receiving equally in all directions.
IPA	Intermediate Power Amplifier. The equipment that provides required pow gain to the uplink signal for application to the final power amplifier (FPA

L

LINK	A link is: *a.* A portion of a communication circuit. *b.* A channel or circuit designed to be connected in tandem with oth channels or circuits. *c.* A radio path between two points, called a radio link; the resulta circuit may be unidirectional, half duplex, or duplex.
LNA	Low Noise Amplifier. An amplifier that operates with an inherently high signal-to-noise ratio than is usually available from a standard amplifie

M

MONOSCAN	A tracking antenna feed containing five-horns; all tracking functions a handled by the four outer horns and communications is handled by th center horn.

N

NARROWBAND	Any 40 MHz rf segment of the military satellite communication frequenc band.

P

PA	Power Amplifier. The equipment within the AN/FSC-78(V) and AN/FSC-79 that provides high power amplification to the uplink carrier.
PBI	Push Button Indicator. An indicator switch; i.e., a switch that contains an indicator that displays the position in which the switch is placed.
PCB	Printed Circuit Board. An insulated board that contains a circuit in which wires connecting discrete components have been replaced by conductive printed, painted, or etched strips.
PIN	P (positive donor) I (intrinsic) N (negative donor). A diode made by diffusing the semiconductor with P material from one side and N material from the other side, so controlled that this region separates the P and N region. The storage time of the diode is too long to rectify at microwave frequencies, consequently it acts as an attenuator at these frequencies.
PS	Power Supply. A unit that changes ac to dc and maintains a constant preset voltage or current output.

R

CVR	Receiver. The portion of a communication system that converts a high frequency into a lower frequency.
GMU	Receiver Gain Monitor Unit. A unit unique to the AN/FSC-78(V) that automatically switches the standby receiver into operation when a receiver gain fault occurs.

S

CR	Silicon Controlled Rectifier.
NALERT	A device that emits an audible alarm in response to a system fault condition.
SLU	System Status Logic Unit. Equipment located in unit 15 which performs system logic processing and provides command interface between the FSSP and the various terminal equipment.

T

WT	Traveling Wave Tube. An electron tube in which a beam of electrons interact repeatedly with a guided E-H wave moving in sync with it and in such a way that a net transfer of energy occurs between the beam and the traveling wave.

U

T	Unijunction Transistor.

V

O	Voltage Controlled Oscillator.

W

G	Waveguide. A transmission line comprising a hollow conducting tube within which electromagnetic waves are propagated.
EBAND	The full 500 MHz rf bandwidth of the DSCS system between the frequencies of 7.9 to 8.4 GHz.

X

X-BAND	The military SATCOM band of radio frequencies, from 7.25 to 8.4
XMTR	Transmitter. Equipment used to generate and amplify an rf carrier, mod the carrier, and radiate the modulated rf carrier from an antenna.

INDEX

	Paragraphs	Pages
Adjustment:		
Direct current control HTA-9A1 power supplies:		
PS1, PS2	3-91	3-157
PS3:		
Overcurrent	3-92	3-158
Voltage	3-93	3-159
Electronic control amplifier HTA-9A2, 9A3:		
Dc offset adjustment	3-97	3-164
Integrator limit adjustment	3-95	3-162
Tachometer balance adjustment	3-96	3-163
Overvoltage protectors:		
HTA-9A1VR1 through VR4	3-90	3-156
14A9Z1 through Z3	3-76	3-147
Power supplies HTA-8A24PS1	3-84	3-149
14A9PS2 through PS4	3-74	3-146
Synchros:		
Coarse zeroing	3-109	3-176
Fine electrical alignment	3-110	3-176
Alignment:		
Azimuth data module limit switch HTA-8A7A1S1	3-112	3-179
Elevation data module limit switch HTA-6A6A1S1	3-111	3-177
Instrument servo assembly 14A8A1, A2	4-5	4-3
Synchro:		
Coarse	3-109	3-176
Fine	3-110	3-176
tenna ancillary equipment group HTA-12:		
Circuit analysis	2-28	2-35
Azimuth, elevation drive assembly 1, 2	2-29	2-35
Blower motor B2	2-29 b	2-35
Dc drive motor B1	2-29 a	2-35
Dc tachometer-generator G1	2-29 d	2-35
Electric disk brake A1	2-29 c	2-35
escription and data	1-11	1-4
unctional analysis	2-8 d	2-12
rformance test	3-174	3-209
moval and replacement of subassemblies:		
Blower motor B2	3-102	3-172
Dc drive motor B1 brush replacement	3-104	3-172
Dc tachometer-generator G1 brush replacement	3-103	3-172
Electric disk brake A1	3-101	3-170
Disk brake removal	3-101 a	3-170
Disk brake replacement	3-101 b	3-171

	Paragraphs	Pages
Friction disk replacement	3-101 c	3-172
Tachometer-generator G1	3-100	3-169
Troubleshooting	3-43	3-118
Antenna control panel 14A8:		
Circuit analysis:		
Assembly 14A8	2-9	2-12
Azimuth and elevation slew controls	2-9 c	2-13
Mode selection and displays	2-9 a	2-12
Servo limit indicators	2-9 b	2-13
Instrument servo assembly A1, A2	2-10	2-13
Anti-stickoff networks	2-10 e	2-14
Crossover network	2-10 f	2-14
Instrument servo follow-up mode loop	2-10 i	2-14
Instrument servo manual mode loop	2-10 h	2-14
Mode control group	2-10 b	2-13
Follow-up mode	2-10 b (2)	2-13
Manual mode	2-10 b (1)	2-13
Phase balancing network	2-10 d	2-14
Power group	2-10 a	2-13
Servo amplifier	2-10 c	2-13
Servo gear train	2-10 g	2-14
Description and data	1-6	1-2
Functional analysis	2-8 a	2-11
Maintenance	3- 54	3-134
Performance test	3-124	3-186
Instrument servo assembly A1, A2	3-129	3-187
Instrument servo assembly A1B1, A2B1	4-7	4-7
Removal and replacement of subassemblies:		
Azimuth or elevation slew control R1, R2	3-57	3-134
Indicator assembly DS1, DS2	3-56	3-134
Indicator switch assembly S1 through S4	3-55	3-134
Instrument servo assembly A1, A2	3-58	3-136
Instrument servo assembly A1, A2 component parts	3-59	3-136
Troubleshooting	3-14	3-7
Instrument servo assembly A1, A2	3-15	3-9
Antenna positive and status panel 14A7:		
Circuit analysis:		
Assembly 14A7	2-11	2-16
Analog antenna positive indicators	2-11 c	2-17
Antenna safe interlock switch	2-11 e	2-17
Fault chain	2-11 b	2-17
Fault status indicators	2-11 a	2-16
Maintenance switch	2-11 d	2-17

	Paragraphs	Pages
Mode logic circuit card assembly A1	2-12	2-17
Acquisition/autotrack mode logic	2-12 d	2-19
No signal detect, no signa acquire state	2-12 d (1)	2-19
Signal acquire, no signa detect state	2-12 d (3)	2-19
Signal detect, no signa acquire state	2-12 d (2)	2-19
Fault mode logic	2-12 a	2-18
End of fault mode logi status	2-12 a (5)	2-18
Fault status signa generation	2-12 a (3)	2-18
Operational modes inhibit	2-12 a (2)	2-18
Standby drive threshol inhibit generation	2-12 a (4)	2-18
Standby mode inhibit	2-12 a (1)	2-18
Manual mode logic	2-12 c	2-19
Slave mode logic	2-12 e	2-20
Standby mode logic	2-12 b	2-18
Manual standby mod selection	2-12 b (2)	2-18
Turn-on delay standby mod selection	2-12 b (1)	2-18
Relay circuit card assemblies A4 through A7	2-14	2-21
Servo analog circuit card assemblies A2 and A3	2-13	2-20
Autotrack operation	2-13 b	2-20
Manual handcrank/slave operation	2-13 a	2-20
Manual slew operation	2-13 c	2-21
Servo limit control	2-13 d	2-21
Description and data	1-7	1-2
Functional analysis	2-8 b	2-11
Maintenance	3-60	3-138
Performance test	3-131	3-189
Removal and replacement of subassemblies:		
Azimuth and elevation position indicator DS1, DS2	3-63	3-138
Circuit card assembly A1 through A7	3-64	3-139
Indicator assembly DS3 through DS13	3-62	3-138
Indicator switch assembly S2	3-61	3-138
Troubleshooting	3-20	3-23
ntenna safety interlock group:		
Circuit analysis:		
Antenna safe switch assembly HTA-4A7, 6A9, 8A10, 8A27	2-34	2-39

	Paragraphs	Pages
Breakaway electrical connector plug HTA-P201	2-35	2-39
Reflector door switch HTA-2A1S1	2-36	2-39
Description:		
Antenna safe switch assembly HTA-4A7, 6A9, 8A10, 8A27	1-14	1-12
Reflector door switch HTA-2A1S1	1-15	1-12
Performance test	3-178	3-209
Removal and replacement:		
Antenna safe switch HTA-4A7, 6A9, 8A10, 8A27	3-114	3-182
Antenna safe switch components	3-115	3-182
Contact blocks	3-115 a	3-182
Interlock assembly	3-115 b	3-182
Interlock attachment	3-115 c	3-182
Breakaway electrical connector plug HTA-P201	3-116	3-182
Reflector door switch HTA-2A1S1	3-117	3-183
Troubleshooting	3-53	3-130
Azimuth and elevation data modules HTA-8A7A1 and HTA-6A6A1:		
Adjustment/alignment:		
Azimuth limit switch S1	3-112	3-179
Elevation limit switch S1	3-111	3-177
Synchros:		
Coarse zeroing	3-109	3-176
Fine electrical alignment	3-110	3-176
Circuit analysis:		
Limit switch	2-31	2-37
Synchro transmitter	2-32	2-37
Description:		
Azimuth	1-12	1-12
Elevation	1-13	1-12
Functional analysis	2-8 e	2-12
Performance test	3-176	3-209
Removal and replacement:		
Limit switch S1	3-108	3-175
Synchro B1, B3	3-107	3-175
Syncrho B2	3-106	3-174
Troubleshooting	3-48	3-124
Azimuth cable wrap and data module assembly HTA-8A7:		
Alignment:		
Azimuth data module limit switch S1 alignment	3-112	3-179
Coarse synchro zeroing procedure	3-109	3-176
Fine synchro electrical alignment	3-110	3-176
Circuit analysis	2-30	2-37
Limit switch	2-31	2-37
Synchro transmitter	2-32	2-37

	Paragraphs	Pages
Description and data	1-12	1-12
Functional analysis (data module 8A7A1)	2-8 e	2-12
Maintenance	3-105	3-174
Performance test (data module 8A7A1	3-176	3-209
Removal and replacement of subassemblies:		
Limit switch S1	3-108	3-175
Synchro B1 or B3	3-107	3-175
Synchro B2	3-106	3-174
Troubleshooting	3-48	3-124
C		
rcuit analysis:		
Antenna ancillary group HTA-12:		
Azimuth and elevation drive assembly 1 or 2	2-29	2-35
Dc drive motor	2-29 a	2-35
Dc tachometer-generator	2-29 d	2-35
Electric disk brake	2-29 c	2-35
Motor blower	2-29 b	2-35
Antenna control panel 14A8:		
Assembly circuit analysis	2-9	2-12
Azimuth and elevation slew controls	2-9 c	2-13
Mode selection and displays	2-9 a	2-12
Servo limit indicators	2-9 b	2-13
Instrument servo assembly A1, A2	2-10	2-13
Anti-stickoff network	1-10 e	2-14
Crossover network	2-10 f	2-14
Instrument servo follow-up mode loop	2-10 i	2-14
Instrument servo manual mode loop	2-10 h	2-14
Mode control group	2-10 b	2-13
Follow-up mode	2-10 b (2)	2-13
Manual mode	2-10 b (1)	2-13
Phase balancing network	2-10 d	2-14
Power group	2-10 a	2-13
Servo amplifier	2-10 c	2-13
Servo gear train	2-10 g	2-14
tenna position and status panel 14A7:		
Assembly	2-11	2-16
Analog antenna position indicators	2-11 c	2-17
Antenna safe interlock switch	2-11 e	2-17
Fault chain	2-11 b	2-17
Fault status indicators	2-11 a	2-16
Maintenance switch	2-11 d	2-17
Mode logic circuit card assembly A1	2-12	2-17

	Paragraphs	Pages
Acquisition/autotrack mode logic	2-12 d	2-19
No signal detect, no signa acquire state	2-12 d (1)	2-19
Signal acquire, no signa detect state	2-12 d (3)	2-19
Signal detect, no signa acquire state	2-12 d (2)	2-19
Fault mode logic	2-12 a	2-18
End of fault mode logi status	2-12 a (5)	2-18
Fault status signa generation	2-12 a (3)	2-18
Operational modes inhibit	2-12 a (2)	2-18
Standby drive threshol inhibit generation	2-12 a (4)	2-18
Standby mode inhibit	2-12 a (1)	2-18
Manual mode logic	2-12 c	2-19
Slave mode logic	2-12 e	2-19
Standby mode logic	2-12 b	2-18
Manual standby mod selection	2-12 b (2) 2	2-18
Turn-on delay standby mod selection	2-12 b (1)	2-18
Relay circuit card assemblies A4 through A7	2-14	2-21
Servo analog circuit card assemblies A2 and A3	2-13	2-20
Autotrack operation	2-13 b	2-20
Manual handcrank/slave operation	2-13 a	2-20
Manual slew operation	2-13 c	2-21
Servo limit control	2-13 d	2-21
Azimuth and elevation data modules HTA-8A7A1, 6A6A1:		
Limit switch	2-31	2-37
Synchro transmitter	2-32	2-37
Direct current control HTA-9:		
Assembly circuit analysis	2-24	2-25
Cabinet mounted equipment	2-27	2-34
Electronic control amplifier HTA-9A2, 9A3	2-25	2-25
Circuit card assembly HTA-9A2A1, 9A3A1 LED indicators	2-25 f	2-31
Drive power generation circuits	2-25 c	2-27
Comparison	2-25 c (3)	2-28
Coupling and overloa sensing	2-25 c (6)	2-29
Firing angle limit an torque loop summing	2-25 c (2)	2-28

	Paragraphs	Pages
Pulse shaping/trigge		
lockout		
Scr assembly A2A2 throug	2-25 c (4)	2-28
A2A7 and A3A2 thro		
A3A7		
Gate driver module	2-25 c (5)	2-29
Scr module	2-25 c (5) (a)	2-29
Tachometer loop summing	2-25 c (5) (b)	2-29
Interlock circuits	2-25 c (1)	2-27
Local control circuits	2-25 b	2-25
Major fault detection	2-25 a	2-25
Minor fault detection	2-25 d	2-29
Fuse failure detection	2-25 e	2-30
Overload detection	2-25 e (2)	2-30
Power supply control HTA-9A1	2-25 e (1)	2-30
Motor field voltage generation	2-26	2-25 c
Power control	2-26 a	2-32
Power distribution	2-26 b	2-32
Power supplies:	2-26 c	2-32
5 V dc power supply PS1		
Ac input circuit	2-26 d	2-32
Bias supply	2-26 d (1)	2-32
Main rectifier	2-26 d (2)	2-32
Series voltage regulator	2-26 d (3)	2-32
Normal load regulation	2-26 d (4)	2-32
Overcurrent operation	2-26 d (4) (a)	2-32
Dual 15 V dc power suppl	2-26 d (4) (b)	2-33
PS2		
Ac input circuit	2-26 e	2-33
Bias supply	2-26 e (1)	2-33
Main rectifier	2-26 e (2)	2-33
Series voltage regulator	2-26 e (3)	2-33
Normal load regulation	2-26 e (4)	2-33
Overcurrent operation	2-26 e (4) (a)	2-33
15 V dc power supply PS3	2-26 e (4) (b)	2-33
Ac input circuit	2-26 f	2-34
Bias supply	2-26 f (1)	2-34
Main rectifier	2-26 f (2)	2-34
Series voltage regulator	2-26 f (3)	2-34
Normal load regulation	2-26 f (4)	2-34
Overcurrent operation	2-26 f (4) (a)	2-34
nel and equipment safety controls:	2-26 f (4) (b)	2-34
enna safe switch assembly	2-34	2-39

	Paragraphs	Pages
Breakaway electrical connector plug	2-35	2-39
Reflector door switch	2-36	2-39
Servo power supply assembly 14A9:		
Assembly circuit analysis	2-15	2-21
5 V dc power supply PS4	2-17	2-23
15 V dc power supply PS2, PS3	2-16	2-22
Stow pin control/minor fault summary panel HTA-8A24:		
Assembly circuit analysis	2-18	2-24
Maintenance switch S6	2-20	2-24
Minor drive fault circuit	2-21	2-24
Minor fault summary circuit	2-22	2-24
Rain deflector switch S5	2-19	2-24
Stow pin control	2-23	2-24
Component replacement procedures, general	3-4 c	3-4
Potentiometers	3-4 c (3)	3-4
Relays	3-4 c (1)	3-4
Small components	3-4 c (2)	3-4
Transformers	3-4 c (4)	3-4
Cross-reference index	1-16 c	1-26

INDE

D

	Paragraphs	Pages
Data, tabulated	1-16	1-18
Cross-reference index	1-16 c	1-26
Electrical characteristics	1-16 b	1-18
Physical data	1-16 a	1-18
Description and data:		
Antenna ancillary group HTA-12	1-11	1-4
Antenna control panel 14A8	1-6	1-2
Antenna operate/antenna safe switch assembly	1-14	1-12
Antenna position status panel 14A7	1-7	1-2
Azimuth cable wrap and data module assembly HTA-8A7	1-12	1-12
Direct current control HTA-9	1-10	1-4
Elevation synchro assembly HTA-6A6	1-13	1-12
General description	1-5	1-1
Reflector door switch HTA-2A1S1	1-15	1-12
Servo power supply assembly 14A9	1-8	1-4
Stow pin control/minor fault summary panel HTA-8A24	1-9	1-4
Tabulated data	1-16	1-18
Cross-reference index	1-16 c	1-26
Electrical characteristics	1-16 b	1-18
Physical data	1-16 a	1-18

	Paragraphs	Pages
des, in-circuit measurements	3-3 b (3)	3-3
ct current control HTA-9:		
Adjustment:		
Electronic control amplifier HTA-9A2, 9A3:		
Dc offset	3-97	3-164
Integrator limit	3-95	3-162
Tachometer balance	3-96	3-163
Overvoltage protectors HTA-9A1VR1 through VR4	3-90	3-156
Power supplies:		
HTA-9A1PS1, 9A1PS2 voltage	3-91	3-157
HTA-9A1PS3:		
Overcurrent	3-92	3-158
Voltage	3-93	3-159
Circuit analysis:		
Assembly HTA-9	2-24	2-25
Cabinet-mounted equipment circuit description	2-27	2-34
Electronic control amplifier HTA-9A2,9A3	2-25	2-25
Circuit card assembly HTA-9A2A1, 9A3A1 LED indicators	2-25 f	2-31
Drive power generation circuits	2-25 c	2-27
Comparison	2-25 c (3)	2-28
Coupling and overloa sensing	2-25 c (6)	2-29
Firing angle limit an torque loop summing	2-25 c (2)	2-28
Pulse shaping/trigge lockout	2-25 c (4)	2-28
Scr assembly A2A2 throug A2A7, A3A2 through A3A7	2-25 c (5)	2-29
Gate driver module	2-25 c (5) (a)	2-29
Scr module	2-25 c (5) (b)	2-29
Tachometer loop summing	2-25 c (1)	2-27
Interlock circuits	2-25 b	2-25
Local control circuits	2-25 a	2-25
Major fault detection	2-25 d	2-29
Minor fault detection	2-25 e	2-30
Fuse failure detection	2-25 e (2)	2-30
Overload detection	2-25 e (1)	2-30
Power supply control HTA-9A1	2-26	2-32
Motor field voltage generation	2-26 a	2-32
Power control	2-26 b	2-32
Power distribution	2-26 c	2-32
5 V dc power supplyHTA-9A1PS1	2-26 d	2-32
Ac input circuit	2-26 d (1)	2-32

	Paragraphs	Pages
Bias supply	2-26 d (2)	2-32
Main rectifier	2-26 d (3)	2-32
Series voltage regulator	2-26 d (4)	2-32
Normal load regulation	2-26 d (4) (a)	2-32
Overcurrent operation	2-26 d (4) (b)	2-33
15 V dc power supply HTA-9A1PS2	2-26 e	2-33
Ac input circuit	2-26 e (1)	2-33
Bias supply	2-26 e (2)	2-33
Main rectifier	2-26 e (3)	2-33
Series voltage regulator	2-26 e (4)	2-33
Normal load regulation	2-26 e (4) (a)	2-33
Overcurrent operation	2-26 e (4) (b)	2-33
15 V dc power supplyHTA-9A1PS3	2-26 f	2-34
Ac input circuit	2-26 f (1)	2-34
Bias supply	2-26 f (2)	2-34
Main rectifier	2-26 f (3)	2-34
Series voltage regulator	2-26 f (4)	2-34
Normal load regulation	2-26 f (4) (a)	2-34
Overcurrent operation	2-26 f (4) (b)	2-34
Description	1-10	1-4
Functional analysis	2-8 c	2-11
Performance test:		
HTA-9 subassemblies	3-147	3-193
Electronic control amplifier HTA-9A2, 9A3	3-152	3-194
Power supply control HTA-9A1	3-157	3-197
Power supplies:		
PS1	3-162	3-200
PS2	3-167	3-205
PS3	3-172	3-208
Removal and replacement:		
Cabinet mounted units	3-98	3-167
Cabinet fan B1	3-98 d	3-168
Door interlock switch S1	3-98 c	3-168
Magnetic contactor K1, K2	3-98 a	3-167
Power inductors L1 through L4	3-98 e	3-168
Power-on flasher DS1, DS2	3-98 b	3-168
Electronic control amplifier HTA-9A2, 9A3 components	3-94	3-161
Circuit card assembly A1	3-94 a	3-161
Fuseholders XF1 through XF3	3-94 d	3-162
Fuses F4 through F9	3-94 e	3-162
Relay heater element HR1, HR2	3-94 g	3-162
Scr assemblies A2 through A7	3-94 b	3-161
Thermal relay K1, K2	3-94 f	3-162

	Paragraphs	Pages
Transformer T1	3-94 c	3-161
Power supply control HTA-9A1 units	3-86	3-150
Circuit breakers CB1, CB2	3-86 b	3-150
Fuseholders XF1 through XF4	3-86 e	3-151
Overvoltage protectors VR1 through VR4	3-86 d	3-151
Power supplies PS1, PS2, PS3	3-86 c	3-150
Relays K1, K2, K3	3-86 a	3-150
Power supply components:		
PS1	3-87	3-151
PS2	3-88	3-153
PS3	3-89	3-154
Troubleshooting:		
Basic	3-33	3-65
Electronic control amplifier HTA-9A2, 9A3	3-34	3-72
Power supply control HTA-9A1	3-35	3-78
Power supplies:		
PS1	3-36	3-85
PS2	3-37	3-88
PS3	3-38	3-93

E

	Paragraphs	Pages
trical characteristics	1-16 b	1-18

F

	Paragraphs	Pages
s and records	1-2	1-1
crepancy in shipment report	1-2 c	1-1
ports of maintenance and unsatisfactory equipment	1-2 a	1-1
ports of packaging and handling deficiencies	1-2 b	1-1
onal analysis:		
jor faults monitor and display	2-3	2-1
ntenna limits	2-3 c	2-1
ntenna safe	2-3 g	2-4
ntenna stowed	2-3 b	2-1
rakes manually released	2-3 e	2-4
rect current control failure	2-3 f	2-4
otor overheat/handcrank engaged	2-3 d	2-4
wer failure	2-3 a	2-1
dio frequency cutoff	2-3 h	2-4
distribution	2-5	2-6
ntrol power	2-5 a	2-6
ve power	2-5 b	2-6
control-minor fault summary power	2-5 c	2-6
nd control equipment operating modes	2-6	2-6

	Paragraphs	Pages
Acquisition mode	2-6 c	2-8
Autotrack mode	2-6 d	2-8
Manual mode	2-6 b	2-6
Manual mode antenna positioning	2-6 b (2)	2-6
Handcrank operation	2-6 b (2) (a)	2-6
Slew operation	2-6 b (2) (b)	2-8
Manual mode selection	2-6 b (1)	2-6
Manual mode servo analog circuit operation	2-6 b (3)	2-8
Slave mode	2-6 e	2-8
Standby mode	2-6 a	2-6
Servo and control loop description	2-8	2-11
Antenna control panel 14A8 operation	2-8 a	2-11
Antenna drive assemblies HTA-12A1 through 12A4 operation	2-8 d	2-12
Antenna position and status panel 14A7 operation	2-8 b	2-11
Data modules HTA-6A6A1 and 8A7A1 operation	2-8 e	2-12
Direct current control HTA-9 operation	2-8 c	2-11
Servo control	2-2	2-1
Antenna position feedback	2-2 a	2-1
Mode control	2-2 b	2-1
Servo control and drive fault detection and control	2-7	2-8
Major faults	2-7 a	2-9
Antenna safe	2-7 a (8)	2-10
Handcrank engaged	2-7 a (2)	2-9
Manual brake release	2-7 a (5)	2-9
Motor hot	2-7 a (3)	2-9
Power failure	2-7 a (1)	2-9
Scr failure	2-7 a (6)	2-9
Servo and electrical limits	2-7 a (4)	2-9
Stowed	2-7 a (7)	2-10
Major maintenance	2-7 b	2-10
Minor faults	2-7 c	
Air conditioner/transmit filter temperature	2-7 c (4)	2-10
Lube oil pressure	2-7 c (2)	2-10
Nitrogen pressure	2-7 c (3)	2-10
Scr fuse failure	2-7 c (1)	2-10
Minor maintenance	2-7 d	2-11
Stow and rain deflector control and minor faults monitor and display	2-4	2-4
Minor drive fault status	2-4 c	2-4
Minor fault summary status	2-4 d	2-4
Rain deflector control/status	2-4 b	2-4
Stow control	2-4 a	2-4

G

	Paragraphs	Pages
General description	1-5	1-1
General repair instructions	3-4	3-3
General troubleshooting instructions	3-3	3-2
I		
n-circuit resistance measurements	3-3 b	3-3
Diodes	3-3 b (3)	3-3
Npn transistors	3-3 b (1)	3-3
Pnp transistors	3-3 b (2)	3-3
strument servo assembly 14A8A1, 14A8A2:		
Alignment	4-5	4-3
Circuit analysis	2-10	2-13
Anti-stickoff network	2-10 e	2-14
Crossover network	2-10 f	2-14
Instrument servo follow-up mode loop	2-10 i	2-14
Instrument servo manual mode loop	2-10 h	2-14
Mode control group	2-10 b	2-13
Follow-up mode	2-10 b (2)	2-13
Manual mode	2-10 b (1)	2-13
Phase balancing network	2-10 d	2-14
Power group	2-10 a	2-13
Servo amplifier	2-10 c	2-13
Servo gear train	2-10 g	2-14
rformance test	4-7	4-7
emoval and replacement:		
Direct support maintenance:		
Assembly	3-58	3-136
Component parts	3-59	3-136
General support maintenance:		
Clutch L1	4-4	4-2
Servo motor B1	4-6	4-4
Synchro B2, B3	4-3	4-2
ubleshooting	3-15	3-9
M		
enance (see adjustment, alignment, performance test, removal and cement, and troubleshooting)		
in connector repair procedures	3-4 d	3-4
N		
ansistors, in-circuit measurements:		
stance	3-3 b (1)	3-3
age	3-3 a	3-2
O		
ircuit resistance measurements	3-3 c	3-3
P		

	Paragraphs	Pages
Performance test:		
Antenna ancillary group HTA-12	3-174	3-209
Antenna control panel 14A8	3-124	3-186
Instrument servo assembly 14A8A1, A2	3-129	3-187
Instrument servo assembly 14A8A1B1, A2B1	4-7	4-7
Antenna position and status panel 14A7	3-131	3-189
Antenna safety interlock group	3-178	3-209
Azimuth and elevation data modules HTA-8A7A1 and HTA-6A6A1	3-176	3-209
Direct current control HTA-9	3-147	3-193
Electronic control amplifier A2, A3	3-152	3-194
Power supply control A1	3-157	3-197
Power supplies:		
PS1	3-162	3-200
PS2	3-167	3-205
PS3	3-172	3-208
Instrument servo assembly 14A8A1, 14A8A2	3-129	3-187
Instrument servo assembly 14A8A1B1, 14A8A2B1	4-7	4-7
Servo and control equipment group	3-122	3-184
Servo power supply assembly 14A9	3-133	3-189
Power supplies:		
PS2, PS3	3-138	3-190
PS4	3-143	3-192
Stow pin control/minor fault summary panel HTA-8A24	3-145	3-193
Physical data	3-16 a	1-18
Pnp transistors, in-circuit measurements:		
Resistance	3-3 b (2)	3-3
Voltage	3-3 a	3-2
Potentiometers, replacement, general	3-4 c (3)	3-4
Purpose and use	1-5 a	1-1
R		
Relays, replacement, general	3-4 c (1)	3-4
Removal and replacement:		
Antenna ancillary group HTA-12:		
Blower motor B2	3-102	3-172
Dc drive motor B1, brushes	3-104	3-172
Dc tachometer-generator G1 brushes	3-103	3-172
Electric disk brake A1	3-101	3-170
Disk brake removal	3-101 a	3-170
Disk brake replacement	3-101 b	3-171
Friction disk	3-101 c	3-172
Tachometer-generator G1	3-100	3-169
Antenna control panel 14A8:		

	Paragraphs	Pages
Azimuth or elevation slew control R1, R2	3-57	3-134
Indicator assembly DS1, DS2	3-56	3-134
Indicator switch assembly S1 through S4	3-55	3-134
Instrument servo assembly A1, A2	3-58	3-136
Component parts	3-59	3-136
Antenna position and status panel 14A7:		
Azimuth and elevation position indicator DS1, DS2	3-63	3-138
Circuit card assembly A1 through A7	3-64	3-139
Indicator assembly DS3 through DS13	3-62	3-138
Indicator switch assembly S2	3-61	3-138
Antenna safety interlock group:		
Antenna safe switch	3-114	3-182
Antenna safe switch components	3-115	3-182
Contact block	3-115 a	3-182
Interlock assembly	3-115 b	3-182
Interlock attachment	3-115 c	3-182
Breakaway electrical connector plug HTA-P201	3-116	3-182
Reflector door switch	3-117	3-183
Azimuth and elevation data modules HTA-8A7A1 and HTA-6A6A1:		
Limit switch S1	3-108	3-175
Synchro B1, B3	3-107	3-175
Synchro B2	3-106	3-174
Direct current control HTA-9:		
Cabinet mounted units	3-98	3-167
Cabinet fan B1	3-98 d	3-168
Door interlock switch S1	3-98 c	3-168
Magnetic contactor K1, K2	3-98 a	3-167
Power inductors L1 through L4	3-98 e	3-168
Power-on flasher DS1, DS2	3-98 b	3-168
Electronic control amplifier HTA	3-94	3-161
Circuit card assembly A1	3-94 a	3-161
Fuseholders XF1 through XF3	3-94 d	3-162
Fuses F4 through F9	3-94 e	3-162
Relay heater element HR1, HR2	3-94 g	3-162
Scr assemblies A2 through A7	3-94 b	3-161
Thermal relay K1, K2	3-94 f	3-162
Transformer T1	3-94 c	3-161
Power supply control HTA-9A1 units	3-86	3-150
Circuit breakers CB1, CB2	3-86 b	3-150
Fuseholders XF1 through XF4	3-86 e	3-151
Overvoltage protectors VR1 through VR4	3-86 d	3-151
Power supplies PS1, PS2, PS3	3-86 c	3-150
Relays K1, K2, K3	3-86 a	3-150

	Paragraphs	Pages
Power supply components:		
PS1	3-87	3-151
PS2	3-88	3-153
PS3	3-89	3-154
Instrument servo assembly 14A8A1, 14A8A2:		
Direct support maintenance:		
Assembly	3-58	3-136
Component parts	3-59	3-136
General support maintenance:		
Clutch L1	4-4	4-2
Servo motor B1	4-6	4-4
Synchro B2, B3	4-3	4-2
Servo power supply assembly 14A9:		
Circuit breakers CB1 through CB7	3-67	3-140
Overvoltage protectors Z1, Z2, Z3	3-75	3-147
Power supplies:		
PS1	3-68	3-140
PS2, PS3, PS4	3-69	3-141
Power supply components:		
PS2, PS3	3-70	3-141
PS4	3-71	3-143
Stow pin control/minor fault summary panel HTA-8A24:		
Circuit breaker CB1	3-82	3-149
Indicator assemblies DS1 through DS10	3-80	3-149
Indicator switch assemblies S1 through S4	3-78	3-149
Power supply PS1	3-83	3-149
Relays K1 through K15 and diodes CR16, CR17	3-81	3-149
Switch assemblies S5, S6	3-79	3-149
Repair instructions, general	3-4	3-3
Component replacement procedure	3-4 c	3-4
Potentiometers	3-4 c (3)	3-4
Relays	3-4 c (1)	3-4
Small components	3-4 c (2)	3-4
Transformers	3-4 c (4)	3-4
Multipin connectors	3-4 d	3-4
Replacement techniques	3-4 b	3-4
Soldering and unsoldering procedures	3-4 a	3-3
Reporting of errors	1-4	1-1

S

Servo power supply assembly 14A9:
Adjustment:
Overcurrent:

	Paragraphs	Pages
PS2, PS3	3-72	3-143
PS4	3-73	3-144
Overvoltage protectors Z1, Z2, Z3	3-76	3-147
Power supplies PS2, PS3, PS4:		
Coarse voltage	3-66	3-140
Voltage	3-74	3-146
Circuit analysis:		
Assembly 14A9	2-15	2-21
Power supplies:		
PS2, PS3	2-16	2-22
PS4	2-17	2-23
Description	1-8	1-4
Performance test	3-133	3-189
Power supplies:		
PS2, PS3	3-138	3-190
PS4	3-143	3-192
Removal and replacement:		
Circuit breakers CB1 through CB7	3-67	3-140
Overvoltage protectors Z1, Z2, Z3	3-75	3-147
Power suppies:		
PS1	3-68	3-140
PS2, PS3, PS4	3-69	3-141
Power supply components:		
PS2, PS3	3-70	3-141
PS4	3-71	3-143
Troubleshooting	3-25	3-33
Power supplies	3-26	3-36
Small components, replacement	3-4 c (2)	3-4
Soldering and unsoldering procedures	3-4 a	3-3
Stow pin control/minor fault summary panel HTA-8A24:		
Adjustment, power supply PS1	3-84	3-149
Circuit analysis:		
Assembly	2-18	2-24
Maintenance switch S6	2-20	2-24
Minor drive fault circuit	2-21	2-24
Minor fault summary circuit	2-22	2-24
Rain deflector switch S5	2-19	2-24
Stow pin control	2-23	2-24
Description	1-9	1-4
Functional analysis	2-4	2-4
Minor drive fault status	2-4 c	2-4
Minor fault summary status	2-4 d	2-4
Rain deflector control/status	2-4 b	2-4

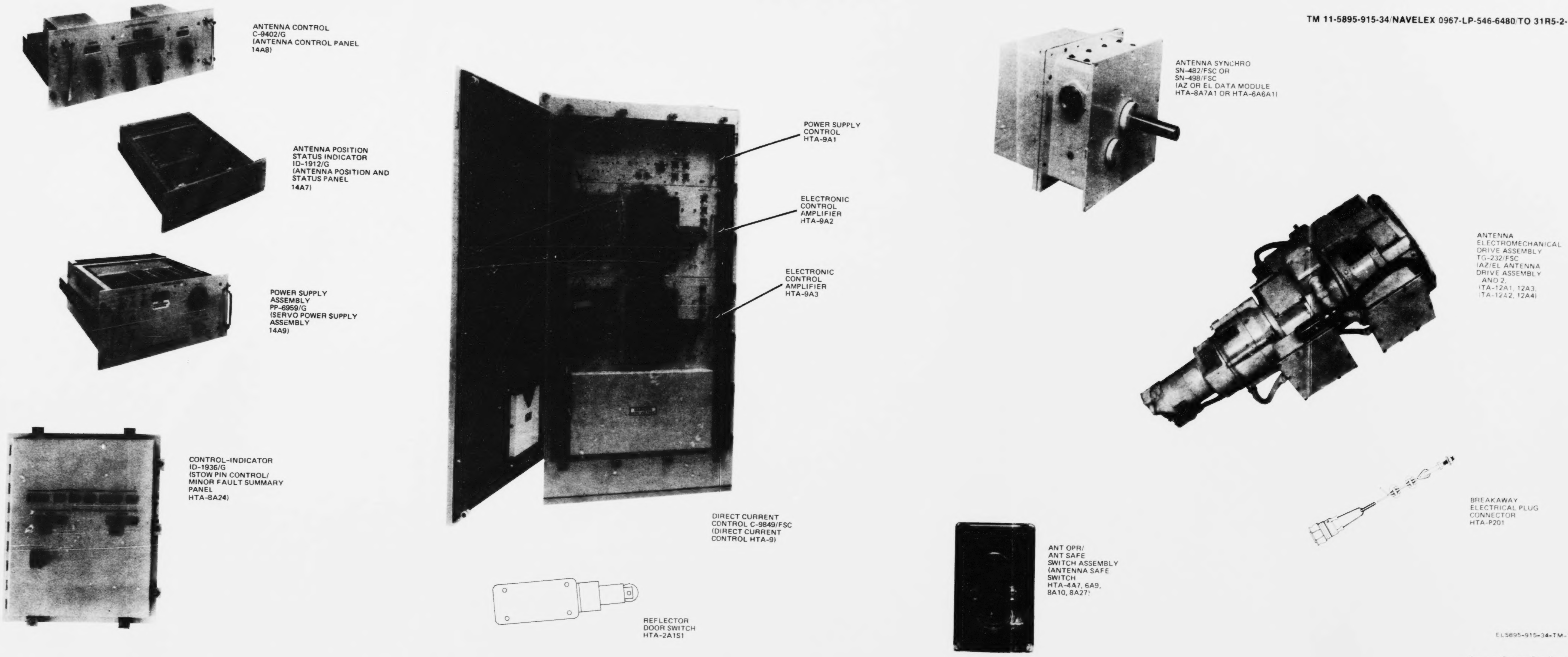
	Paragraphs	Page
Stow control	2-4 a	2-4
Performance test	3-145	3-193
Removal and replacement:		
Circuit breaker CB1	3-82	3-149
Indicator assemblies DS1 through DS10	3-80	3-149
Indicator switch assemblies S1 through S4	3-78	3-149
Power supply PS1	3-83	3-149
Relays K1 through K15 and diodes CR16 and CR17	3-81	3-149
Switch assemblies S5 and S6	3-79	3-149
Troubleshooting	3-31	3-58
T		
Tabulated data (see data, tabulated)		
Testing (see performance test)		
Transformers, replacement	3-4 c (4)	3-4
Troubleshooting:		
Antenna ancillary equipment group HTA-12	3-43	3-118
Antenna control panel 14A8	3-14	3-7
Instrument servo assembly A1, A2	3-15	3-9
Antenna position and status panel 14A7	3-20	3-23
Antenna satety interlock group	3-53	3-130
Azimuth and elevation data modules HTA-8A7A1 and HTA-6A6A1	3-48	3-124
Direct current control HTA-9	3-33	3-65
Electronic control amplifier A2, A3	3-34	3-72
Power supply control A1	3-35	3-78
Power supplies:		
PS1	3-36	3-85
PS2	3-37	3-88
PS3	3-38	3-91
General instructions	3-3	3-2
In-circuit resistance measurements	3-3 b	3-3
Diodes	3-3 b (3)	3-3
Npn transistors	3-3 b (1)	3-3
Pnp transistors	3-3 b (2)	3-3
Out-of-circuit resistance measurements	3-3 c	3-3
Voltage measurements	3-3 a	3-2
Servo and control equipment group	3-9	3-5
Servo power supply assembly 14A9	3-25	3-33
Power supplies	3-26	3-36
Stow pin control/minor fault summary panel HTA-8A24	3-31	3-58
V		
Voltage and resistance measurements, general	3-1	3-1
Voltage measurements, general troubleshooting	3-3	3-2

☆ U.S. GOVERNMENT PRINTING OFFICE : 1990 0 - 261-872

MAPS

TRANSPOSED TO

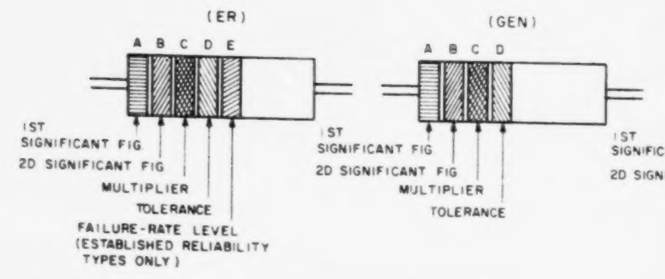
END OF VOLUME


ANTENNA CONTROL
C-9402/G
(ANTENNA CONTROL PANEL
14A8)
ANTENNA POSITION
STATUS INDICATOR
ID-1912/G
(ANTENNA POSITION AND
STATUS PANEL
14A7)
POWER SUPPLY
ASSEMBLY
PP-6959/G
(SERVO POWER SUPPLY
ASSEMBLY
14A9)
CONTROL-INDICATOR
ID-1936/G
(STOW PIN CONTROL/
MINOR FAULT SUMMARY
PANEL
HTA-8A24)
POWER SUPPLY
CONTROL
HTA-9A1
ELECTRONIC
CONTROL
AMPLIFIER
HTA-9A2
ELECTRONIC
CONTROL
AMPLIFIER
HTA-9A3
DIRECT CURRENT
CONTROL C-9849/FSC
(DIRECT CURRENT
CONTROL HTA-9)
REFLECTOR
DOOR SWITCH
HTA-2A1S1
ANTENNA SYNCHRO
SN-482/FSC OR
SN-498/FSC
(AZ OR EL DATA MODULE
HTA-8A7A1 OR HTA-6A6A1)
ANTENNA
ELECTROMECHANICAL
DRIVE ASSEMBLY
TG-232/FSC
(AZ/EL ANTENNA
DRIVE ASSEMBLY
AND 2,
TA-12A1, 12A3,
TA-12A2, 12A4)
ANT OPR/
ANT SAFE
SWITCH ASSEMBLY
(ANTENNA SAFE
SWITCH
HTA-4A7, 6A9,
8A10, 8A27)
BREAKAWAY
ELECTRICAL PLUG
CONNECTOR
HTA-P201

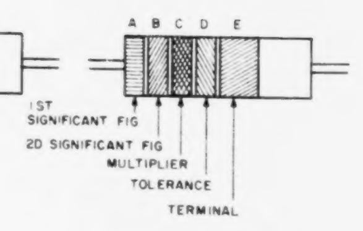
EL5895-915-34-TM-18

Servo and control equipment

best copy available


(ER)
A B C D E
1ST SIGNIFICANT FIG
2D SIGNIFICANT FIG
MULTIPLIER
TOLERANCE
FAILURE-RATE LEVEL (ESTABLISHED RELIABILITY TYPES ONLY)
(GEN)
A B C D
1ST SIGNIFICANT FIG
2D SIGNIFICANT FIG
MULTIPLIER
TOLERANCE

COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS


A B C D E
1ST SIGNIFICANT FIG
2D SIGNIFICANT FIG
MULTIPLIER
TOLERANCE
TERMINAL

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS

TABLE 1
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM
BLACK	0	BLACK	0	BLACK	1			BROWN	M=1.0	
BROWN	1	BROWN	1	BROWN	10			RED	P=0.1	
RED	2	RED	2	RED	100			ORANGE	R=0.01	
ORANGE	3	ORANGE	3	ORANGE	1,000			YELLOW	S=0.001	
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE		SOLDERABLE
GREEN	5	GREEN	5	GREEN	100,000	GOLD	±5			
BLUE	6	BLUE	6	BLUE	1,000,000	RED	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY)			
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7							
GRAY	8	GRAY	8	SILVER	0.01					
WHITE	9	WHITE	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE)

BAND D — THE RESISTANCE TOLERANCE

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE-RATE LEVEL (PERCENT FAILURE PER 1,000 HOURS) ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL

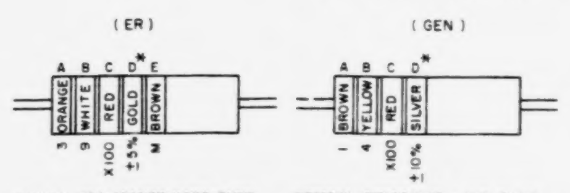
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE

2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED, IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

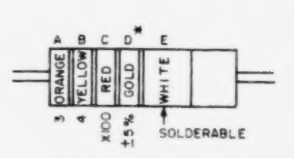
EXAMPLES OF COLOR CODING


(ER)
A B C D* E
ORANGE
WHITE
RED
GOLD
BROWN
3 9 X100 ±5% M
(GEN)
A B C D*
BROWN
YELLOW
RED
SILVER
1 4 X100 ±10%

NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±5%
FAILURE RATE LEVEL M

NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

COMPOSITION-TYPE RESISTORS

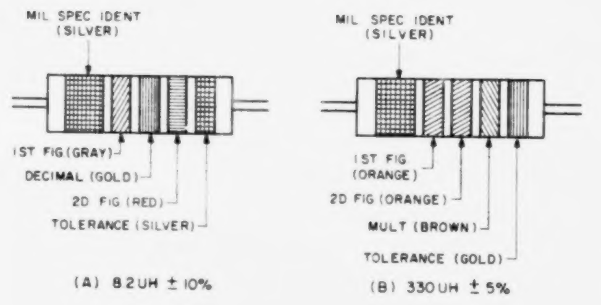

A B C D* E
ORANGE
YELLOW
RED
GOLD
WHITE
3 4 X100 ±5%
SOLDERABLE

NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS


MIL SPEC IDENT (SILVER)
1ST FIG (GRAY)
DECIMAL (GOLD)
2D FIG (RED)
TOLERANCE (SILVER)
MIL SPEC IDENT (SILVER)
1ST FIG (ORANGE)
2D FIG (ORANGE)
MULT (BROWN)
TOLERANCE (GOLD)

(A) 8.2UH ±10%

(B) 330UH ±5%

COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF THE CODING FOR AN 8.2UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330UH INDUCTOR ARE ILLUSTRATED.

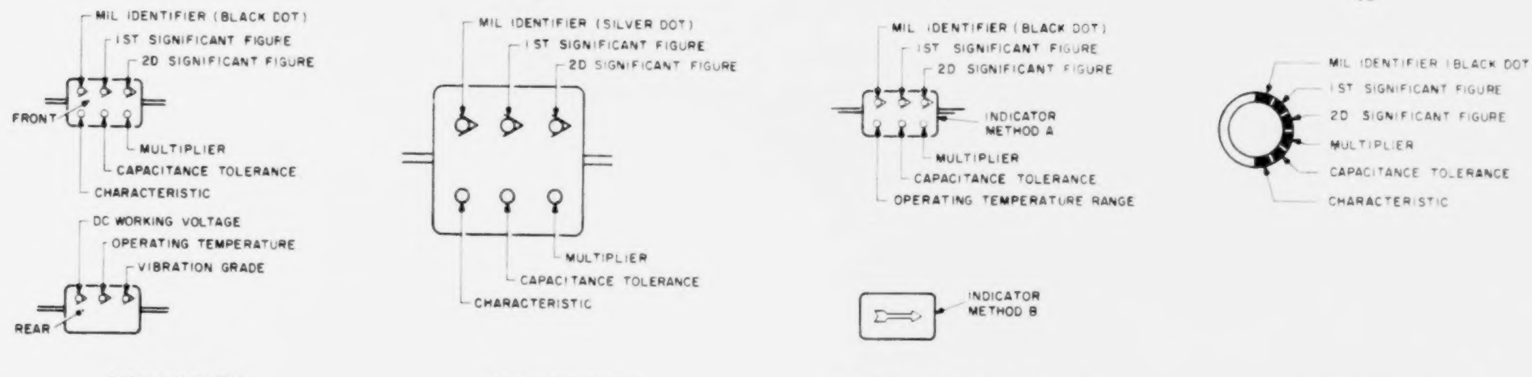
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB


CM
MIL IDENTIFIER (BLACK DOT)
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
FRONT
MULTIPLIER
CAPACITANCE TOLERANCE
CHARACTERISTIC
DC WORKING VOLTAGE
OPERATING TEMPERATURE
VIBRATION GRADE
REAR
CN
MIL IDENTIFIER (SILVER DOT)
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
MULTIPLIER
CAPACITANCE TOLERANCE
CHARACTERISTIC
CY
MIL IDENTIFIER (BLACK DOT)
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
INDICATOR METHOD A
MULTIPLIER
CAPACITANCE TOLERANCE
OPERATING TEMPERATURE RANGE
INDICATOR METHOD B
CB
MIL IDENTIFIER (BLACK DOT)
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
MULTIPLIER
CAPACITANCE TOLERANCE
CHARACTERISTIC

MICA-DIELECTRIC

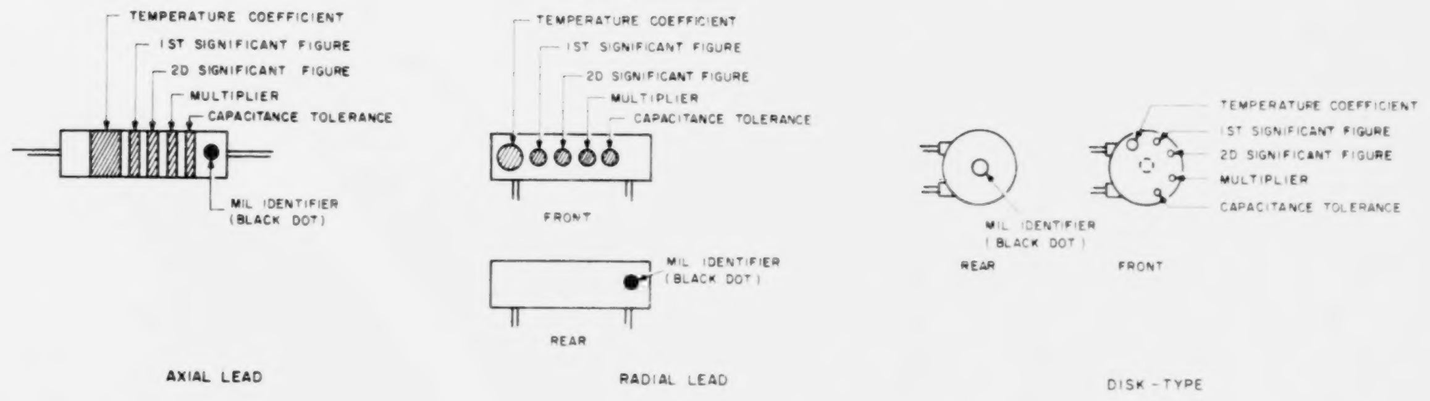
PAPER-DIELECTRIC

GLASS-DIELECTRIC, GLASS CASE

MICA, BUTTON TYPE

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB

COLOR	MIL ID	1ST SIG FIG	2D SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY, CB	0	0	1			±20%	±20%		A			-55° TO +70°C	10-55 HZ
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				-55° TO +85°C	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				-55° TO +125°C	10-2,000 HZ
GREEN		5	5		±5%				F			500		
BLUE		6	6										-55° TO +150°C	
PURPLE (VIOLET)		7	7											
GRAY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN			0.01	±10%	±10%	±10%	±10%						


TEMPERATURE COEFFICIENT
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
MULTIPLIER
CAPACITANCE TOLERANCE
MIL IDENTIFIER (BLACK DOT)
TEMPERATURE COEFFICIENT
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
MULTIPLIER
CAPACITANCE TOLERANCE
FRONT
MIL IDENTIFIER (BLACK DOT)
REAR
MIL IDENTIFIER (BLACK DOT)
REAR
FRONT
TEMPERATURE COEFFICIENT
1ST SIGNIFICANT FIGURE
2D SIGNIFICANT FIGURE
MULTIPLIER
CAPACITANCE TOLERANCE

AXIAL LEAD

RADIAL LEAD

DISK-TYPE

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC

COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG	2D SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	-30	1	1	10	±1%		
RED	-80	2	2	100	±2%	±0.25 UUF	
ORANGE	-150	3	3	1,000			
YELLOW	-220	4	4				
GREEN	-330	5	5		±5%	±0.5 UUF	
BLUE	-470	6	6				
PURPLE (VIOLET)	-750	7	7				
GRAY		8	8	0.01*			
WHITE		9	9	0.1*	±10%		
GOLD	+100			0.1		±1.0 UUF	
SILVER				0.01			

[1] THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.

[2] LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-25D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.

[3] LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.

[4] TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

* OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE.

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

ESC FM 913-73

Figure FO-1. Color code marking for MIL-STD resistors, inductors, and capacitors.

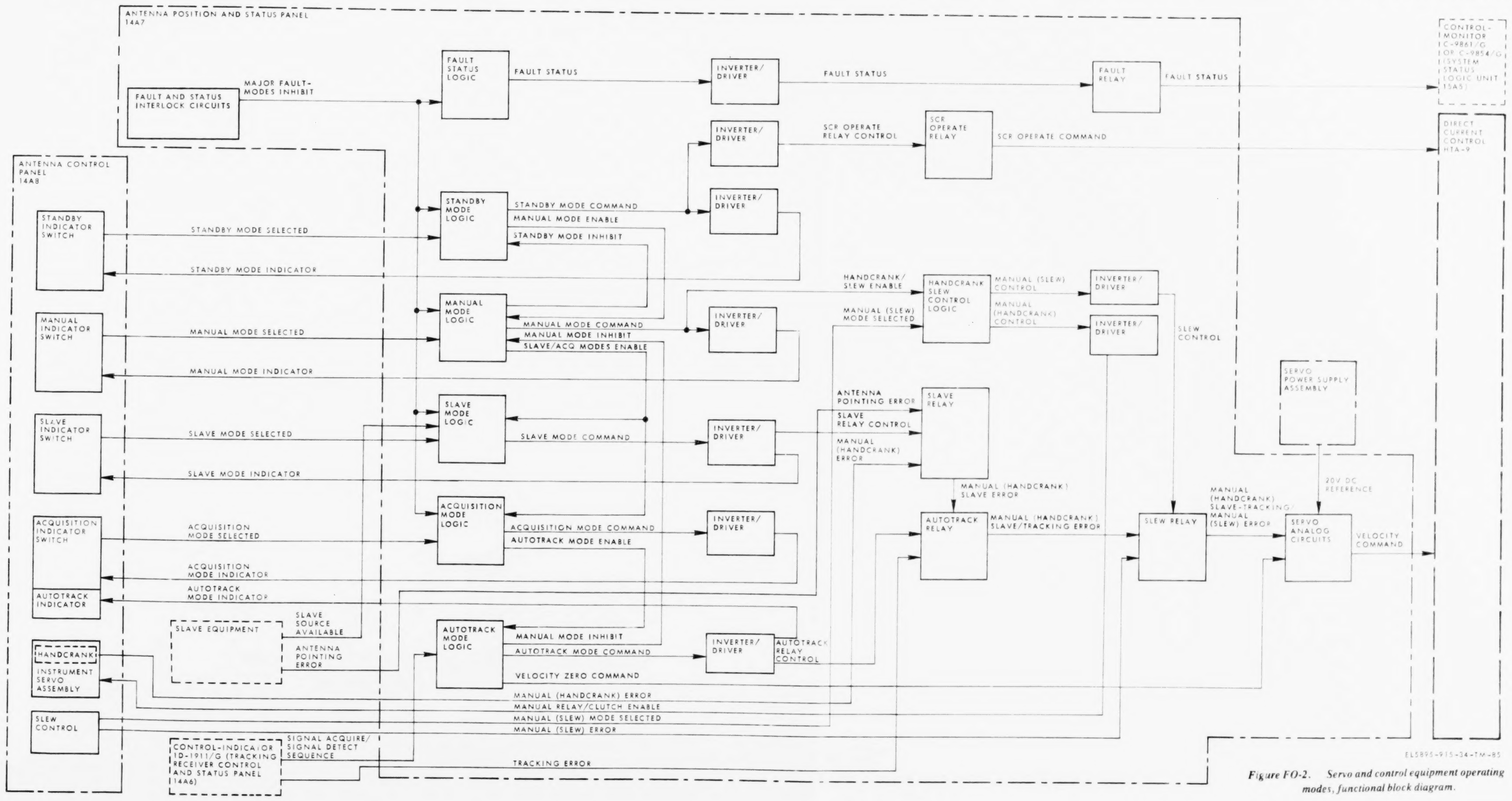

ANTENNA POSITION AND STATUS PANEL 14A7
FAULT AND STATUS INTERLOCK CIRCUITS
MAJOR FAULT-MODES INHIBIT
FAULT STATUS LOGIC
FAULT STATUS
INVERTER/DRIVER
FAULT STATUS
FAULT RELAY
FAULT STATUS
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
INVERTER/DRIVER
SCR OPERATE RELAY CONTROL
SCR OPERATE RELAY
SCR OPERATE COMMAND
DIRECT CURRENT CONTROL HTA-9
ANTENNA CONTROL PANEL 14A8
STANDBY INDICATOR SWITCH
STANDBY MODE SELECTED
STANDBY MODE INDICATOR
STANDBY MODE LOGIC
STANDBY MODE COMMAND
MANUAL MODE ENABLE
STANDBY MODE INHIBIT
INVERTER/DRIVER
MANUAL INDICATOR SWITCH
MANUAL MODE SELECTED
MANUAL MODE INDICATOR
MANUAL MODE LOGIC
MANUAL MODE COMMAND
MANUAL MODE INHIBIT
SLAVE/ACQ MODES ENABLE
INVERTER/DRIVER
HANDCRANK/SLEW ENABLE
MANUAL (SLEW) MODE SELECTED
HANDCRANK SLEW CONTROL LOGIC
MANUAL (SLEW) CONTROL
MANUAL (HANDCRANK) CONTROL
INVERTER/DRIVER
INVERTER/DRIVER
SLEW CONTROL
SERVO POWER SUPPLY ASSEMBLY
SLAVE INDICATOR SWITCH
SLAVE MODE SELECTED
SLAVE MODE INDICATOR
SLAVE MODE LOGIC
SLAVE MODE COMMAND
INVERTER/DRIVER
ANTENNA POINTING ERROR
SLAVE RELAY CONTROL
MANUAL (HANDCRANK) ERROR
SLAVE RELAY
MANUAL (HANDCRANK) SLAVE ERROR
20V DC REFERENCE
ACQUISITION INDICATOR SWITCH
ACQUISITION MODE SELECTED
ACQUISITION MODE INDICATOR
AUTOTRACK INDICATOR
AUTOTRACK MODE INDICATOR
ACQUISITION MODE LOGIC
ACQUISITION MODE COMMAND
AUTOTRACK MODE ENABLE
INVERTER/DRIVER
AUTOTRACK RELAY
MANUAL (HANDCRANK) SLAVE/TRACKING ERROR
SLEW RELAY
MANUAL (HANDCRANK) SLAVE-TRACKING/MANUAL (SLEW) ERROR
SERVO ANALOG CIRCUITS
VELOCITY COMMAND
SLAVE EQUIPMENT
SLAVE SOURCE AVAILABLE
ANTENNA POINTING ERROR
AUTOTRACK MODE LOGIC
MANUAL MODE INHIBIT
AUTOTRACK MODE COMMAND
INVERTER/DRIVER
AUTOTRACK RELAY CONTROL
VELOCITY ZERO COMMAND
HANDCRANK
INSTRUMENT SERVO ASSEMBLY
MANUAL (HANDCRANK) ERROR
MANUAL RELAY/CLUTCH ENABLE
MANUAL (SLEW) MODE SELECTED
MANUAL (SLEW) ERROR
SLEW CONTROL
CONTROL-INDICATOR ID-1911/G (TRACKING RECEIVER CONTROL AND STATUS PANEL 14A6)
SIGNAL ACQUIRE/SIGNAL DETECT SEQUENCE
TRACKING ERROR
EL5895-915-34-TM-85

Figure FO-2. Servo and control equipment operating modes, functional block diagram.

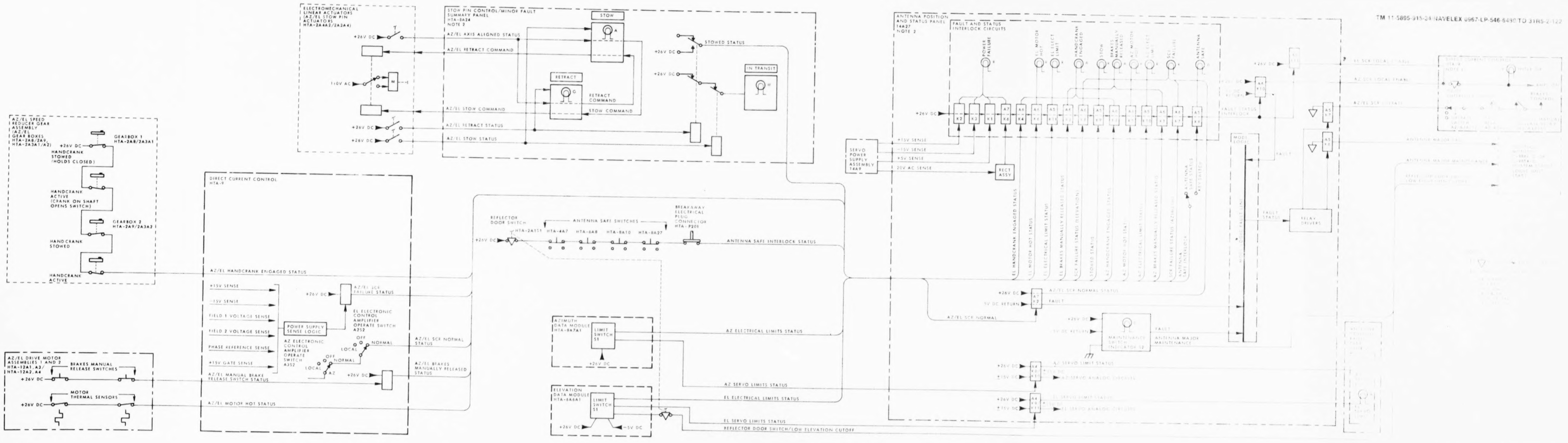
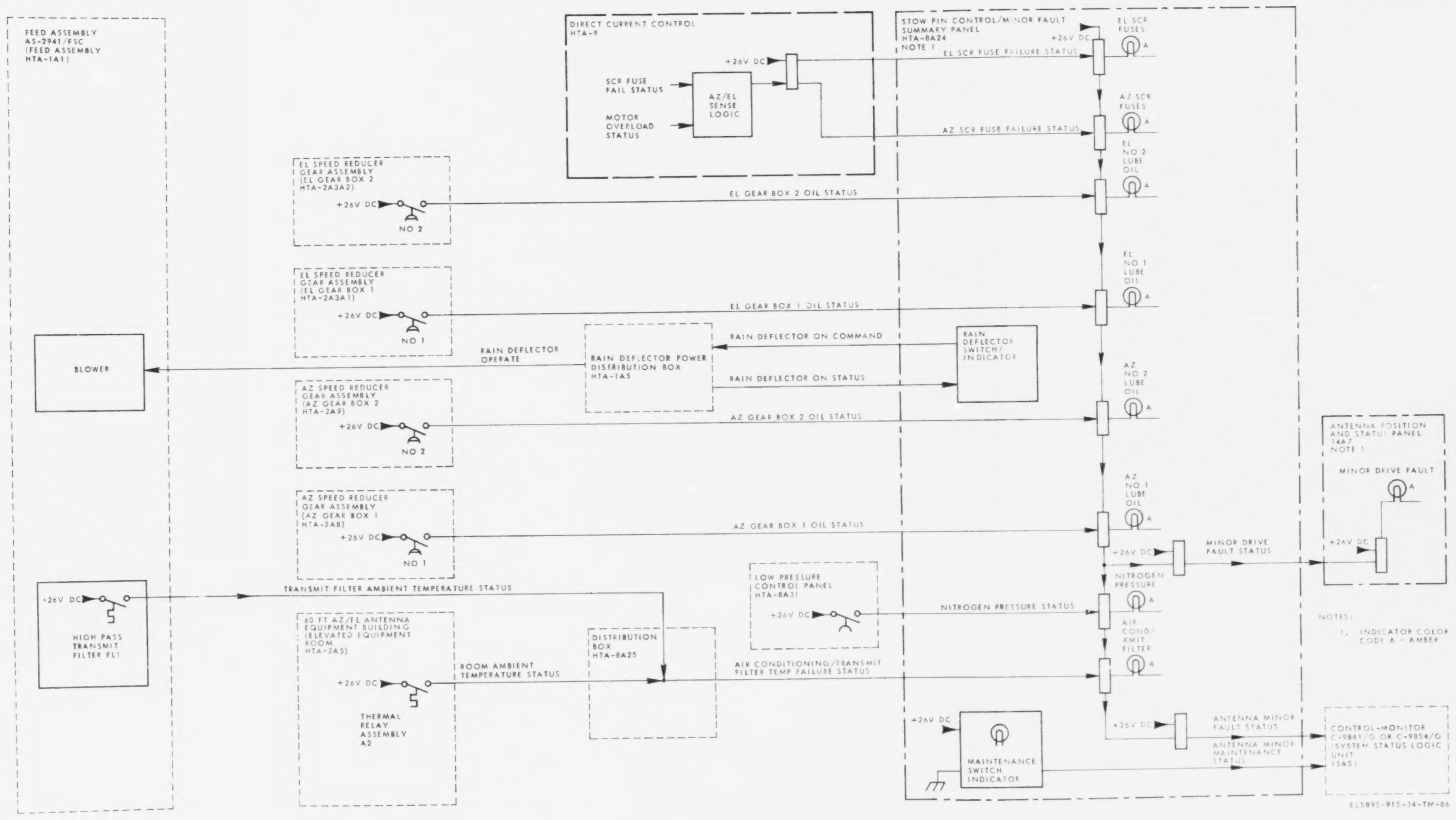

AZ/EL SPEED REDUCER GEAR ASSEMBLY (AZ/EL GEAR BOXES HTA-2A8/2A9, HTA-2A3A1/A2)
+26V DC
GEARBOX 1 HTA-2A8/2A3A1
HANDCRANK STOWED (HOLDS CLOSED)
HANDCRANK ACTIVE (CRANK ON SHAFT OPENS SWITCH)
GEARBOX 2 HTA-2A9/2A3A2
HANDCRANK STOWED
HANDCRANK ACTIVE
ELECTROMECHANICAL LINEAR ACTUATORS (AZ/EL STOW PIN ACTUATORS HTA-2A4A2/2A3A4)
+26V DC
110V AC
M
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24 NOTE 2
AZ/EL AXIS ALIGNED STATUS
AZ/EL RETRACT COMMAND
AZ/EL STOW COMMAND
AZ/EL RETRACT STATUS
AZ/EL STOW STATUS
STOW
RETRACT
RETRACT COMMAND
STOW COMMAND
STOWED STATUS
IN TRANSIT
DIRECT CURRENT CONTROL HTA-9
AZ/EL HANDCRANK ENGAGED STATUS
+15V SENSE
-15V SENSE
FIELD 1 VOLTAGE SENSE
FIELD 2 VOLTAGE SENSE
PHASE REFERENCE SENSE
+15V GATE SENSE
AZ/EL MANUAL BRAKE RELEASE SWITCH STATUS
POWER SUPPLY SENSE LOGIC
AZ/EL SCR FAILURE STATUS
EL ELECTRONIC CONTROL AMPLIFIER OPERATE SWITCH A2S2
AZ ELECTRONIC CONTROL AMPLIFIER OPERATE SWITCH A3S2
OFF
NORMAL
LOCAL
AZ
AZ/EL SCR NORMAL STATUS
AZ/EL BRAKES MANUALLY RELEASED STATUS
AZ/EL MOTOR HOT STATUS
AZ/EL DRIVE MOTOR ASSEMBLIES 1 AND 2 HTA-12A1,A3/ HTA-12A2,A4
BRAKES MANUAL RELEASE SWITCHES
MOTOR THERMAL SENSORS
REFLECTOR DOOR SWITCH
ANTENNA SAFE SWITCHES
HTA-2A1S1
HTA-4A7
HTA-6A8
HTA-8A10
HTA-8A27
BREAKAWAY ELECTRICAL PLUG CONNECTOR HTA-P201
ANTENNA SAFE INTERLOCK STATUS
AZIMUTH DATA MODULE HTA-8A7A1
ELEVATION DATA MODULE HTA-6A6A1
LIMIT SWITCH S1
-5V DC
AZ ELECTRICAL LIMITS STATUS
AZ SERVO LIMITS STATUS
EL ELECTRICAL LIMITS STATUS
EL SERVO LIMITS STATUS
REFLECTOR DOOR SWITCH/LOW ELEVATION CUTOFF
SERVO POWER SUPPLY ASSEMBLY 14A9
+5V SENSE
20V AC SENSE
RECT ASSY
ANTENNA POSITION AND STATUS PANEL 14A27 NOTE 2
FAULT AND STATUS INTERLOCK CIRCUITS
POWER FAILURE
EL MOTOR HOT
EL ELECT LIMIT
HANDCRANK ENGAGED
STOW
BRAKES MANUALLY RELEASED
AZ MOTOR HOT
AZ ELECT LIMIT
SCR FAILURE
ANTENNA SAFE
K2
K3
K1
A7 K6
A6 K4
EL HANDCRANK ENGAGED STATUS
EL MOTOR HOT STATUS
EL ELECTRICAL LIMIT STATUS
EL BRAKES MANUALLY RELEASED STATUS
SCR FAILURE STATUS (ELEVATION)
STOWED STATUS
AZ HANDCRANK ENGAGED STATUS
AZ MOTOR HOT STATUS
AZ ELECTRICAL LIMIT STATUS
AZ BRAKES MANUALLY RELEASED STATUS
SCR FAILURE STATUS (AZIMUTH)
ANTENNA SAFE INTERLOCK
ANTENNA SAFE STATUS
KEY SWITCH
FAULT STATUS INTERLOCK
MODE LOGIC
MODE LOGIC FAULT LINE
FAULT
FAULT STATUS
RELAY DRIVERS
A7 K2
5V DC RETURN
AZ/EL SCR NORMAL
MAINTENANCE SWITCH INDICATOR S2
ANTENNA MAJOR MAINTENANCE
A4
±15V DC
AZ SERVO LIMIT STATUS
AZ SERVO ANALOG CIRCUITS
EL SERVO LIMIT STATUS
EL SERVO ANALOG CIRCUITS
A5 K7
A5 K6
A6 K10
EL SCR LOCAL ENABLE
AZ SCR LOCAL ENABLE
AZ/EL SCR

Figure 1-11-1. Servo and control system major fault detection and control functional block diagram.

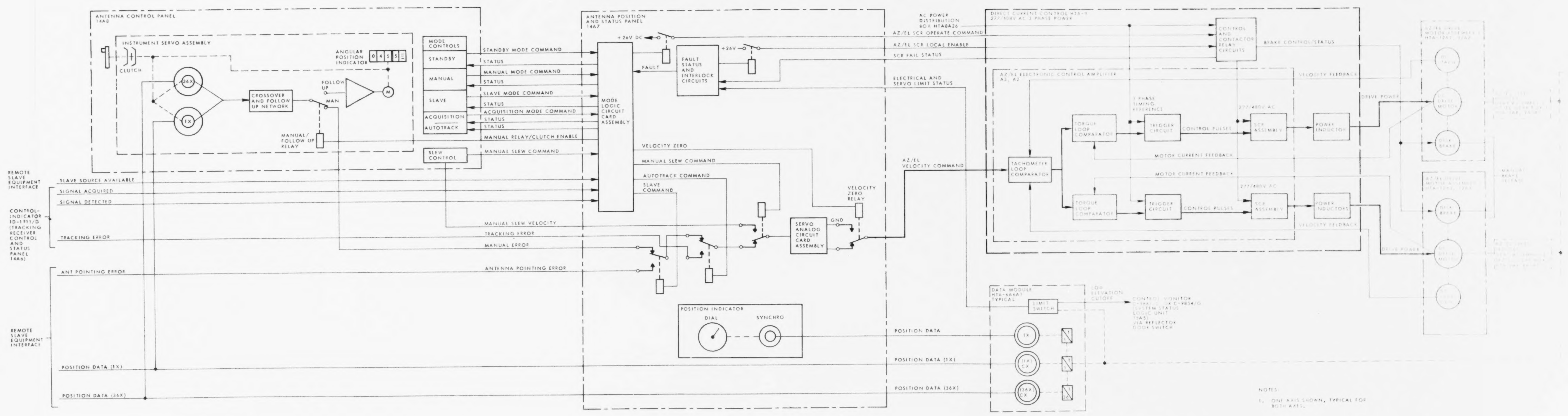

FEED ASSEMBLY
AS-2941/FSC
(FEED ASSEMBLY
HTA-1A1)
BLOWER
+26V DC
HIGH PASS
TRANSMIT
FILTER FL1
DIRECT CURRENT CONTROL
HTA-9
SCR FUSE
FAIL STATUS
MOTOR
OVERLOAD
STATUS
AZ/EL
SENSE
LOGIC
+26V DC
EL SPEED REDUCER
GEAR ASSEMBLY
(EL GEAR BOX 2
HTA-2A3A2)
+26V DC
NO 2
EL GEAR BOX 2 OIL STATUS
EL SPEED REDUCER
GEAR ASSEMBLY
(EL GEAR BOX 1
HTA-2A3A1)
+26V DC
NO 1
EL GEAR BOX 1 OIL STATUS
RAIN DEFLECTOR
OPERATE
RAIN DEFLECTOR POWER
DISTRIBUTION BOX
HTA-1A5
RAIN DEFLECTOR ON COMMAND
RAIN DEFLECTOR ON STATUS
RAIN
DEFLECTOR
SWITCH/
INDICATOR
AZ SPEED REDUCER
GEAR ASSEMBLY
(AZ GEAR BOX 2
HTA-2A9)
+26V DC
NO 2
AZ GEAR BOX 2 OIL STATUS
AZ SPEED REDUCER
GEAR ASSEMBLY
(AZ GEAR BOX 1
HTA-2A8)
+26V DC
NO 1
AZ GEAR BOX 1 OIL STATUS
TRANSMIT FILTER AMBIENT TEMPERATURE STATUS
60 FT AZ/EL ANTENNA
EQUIPMENT BUILDING
(ELEVATED EQUIPMENT
ROOM
HTA-2A5)
+26V DC
THERMAL
RELAY
ASSEMBLY
A2
ROOM AMBIENT
TEMPERATURE STATUS
DISTRIBUTION
BOX
HTA-8A25
LOW PRESSURE
CONTROL PANEL
HTA-8A31
+26V DC
NITROGEN PRESSURE STATUS
AIR CONDITIONING/TRANSMIT
FILTER TEMP FAILURE STATUS
STOW PIN CONTROL/MINOR FAULT
SUMMARY PANEL
HTA-8A24
NOTE 1
+26V DC
EL SCR FUSE FAILURE STATUS
AZ SCR FUSE FAILURE STATUS
EL SCR
FUSES
A
AZ SCR
FUSES
A
EL
NO 2
LUBE
OIL
A
EL
NO 1
LUBE
OIL
A
AZ
NO 2
LUBE
OIL
A
AZ
NO 1
LUBE
OIL
A
+26V DC
NITROGEN
PRESSURE
A
AIR
COND/
XMIT
FILTER
A
+26V DC
+26V DC
MAINTENANCE
SWITCH
INDICATOR
MINOR DRIVE
FAULT STATUS
ANTENNA MINOR
FAULT STATUS
ANTENNA MINOR
MAINTENANCE
STATUS
ANTENNA POSITION
AND STATUS PANEL
14A7
NOTE 1
MINOR DRIVE FAULT
A
+26V DC
CONTROL-MONITOR
C-9861/G OR C-9854/G
(SYSTEM STATUS LOGIC
UNIT
15A5)

NOTES:

1. INDICATOR COLOR CODE A = AMBER

EL5895-915-34-TM-86

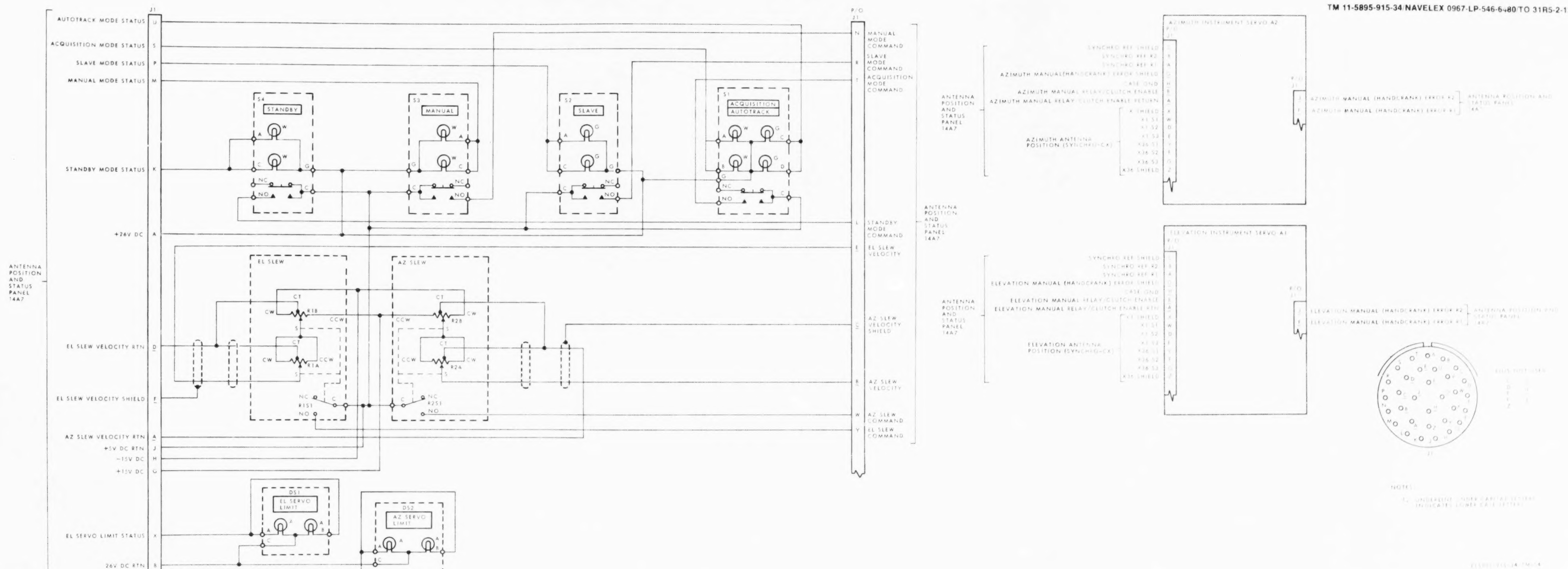
Figure FO-4. Servo and control equipment minor fault detection and control, functional block diagram.


ANTENNA CONTROL PANEL
14A8
INSTRUMENT SERVO ASSEMBLY
CLUTCH
36X
1X
CROSSOVER AND FOLLOW UP NETWORK
ANGULAR POSITION INDICATOR
0 4 5 5
FOLLOW UP
MAN
M
MANUAL/ FOLLOW UP RELAY
MODE CONTROLS
STANDBY
MANUAL
SLAVE
ACQUISITION
AUTOTRACK
SLEW CONTROL
STANDBY MODE COMMAND
STATUS
MANUAL MODE COMMAND
STATUS
SLAVE MODE COMMAND
STATUS
ACQUISITION MODE COMMAND
STATUS
STATUS
MANUAL RELAY/CLUTCH ENABLE
MANUAL SLEW COMMAND
REMOTE SLAVE EQUIPMENT INTERFACE
SLAVE SOURCE AVAILABLE
SIGNAL ACQUIRED
SIGNAL DETECTED
CONTROL-INDICATOR ID-1911/G (TRACKING RECEIVER CONTROL AND STATUS PANEL 14A6)
TRACKING ERROR
ANT POINTING ERROR
REMOTE SLAVE EQUIPMENT INTERFACE
POSITION DATA (1X)
POSITION DATA (36X)
ANTENNA POSITION AND STATUS PANEL 14A7
+26V DC
FAULT
FAULT STATUS AND INTERLOCK CIRCUITS
+26V
MODE LOGIC CIRCUIT CARD ASSEMBLY
VELOCITY ZERO
MANUAL SLEW COMMAND
AUTOTRACK COMMAND
SLAVE COMMAND
MANUAL SLEW VELOCITY
TRACKING ERROR
MANUAL ERROR
ANTENNA POINTING ERROR
VELOCITY ZERO RELAY
GND
SERVO ANALOG CIRCUIT CARD ASSEMBLY
POSITION INDICATOR
DIAL
SYNCHRO
AC POWER DISTRIBUTION BOX HTA8A26
AZ/EL SCR OPERATE COMMAND
AZ/EL SCR LOCAL ENABLE
SCR FAIL STATUS
ELECTRICAL AND SERVO LIMIT STATUS
AZ/EL VELOCITY COMMAND
POSITION DATA
POSITION DATA (1X)
POSITION DATA (36X)
DIRECT CURRENT CONTROL HTA-9
277/408V AC 3 PHASE POWER
CONTROL AND CONTACTOR RELAY CIRCUITS
BRAKE CONTROL/STATUS
AZ/EL ELECTRONIC CONTROL AMPLIFIER A3, A2
VELOCITY FEEDBACK
3 PHASE TIMING REFERENCE
277/480V AC
TACHOMETER LOOP COMPARATOR
TORQUE LOOP COMPARATOR
TRIGGER CIRCUIT
CONTROL PULSES
SCR ASSEMBLY
POWER INDUCTOR
MOTOR CURRENT FEEDBACK
MOTOR CURRENT FEEDBACK
277/480V AC
TORQUE LOOP COMPARATOR
TRIGGER CIRCUIT
CONTROL PULSES
SCR ASSEMBLY
POWER INDUCTORS
VELOCITY FEEDBACK
DRIVE POWER
DRIVE POWER
DATA MODULE HTA-6A6A1 TYPICAL
LIMIT SWITCH
LOW ELEVATION CUTOFF
CONTROL MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5) VIA REFLECTOR DOOR SWITCH
TX
1X CX
36X CX
AZ/EL DRIVE MOTOR ASSEMBLY HTA-12A1, 12A2
DC TACH
DC DRIVE MOTOR
DRIVE BRAKE
MANUAL BRAKE RELEASE
DRIVE BRAKE
DC DRIVE MOTOR

NOTES:

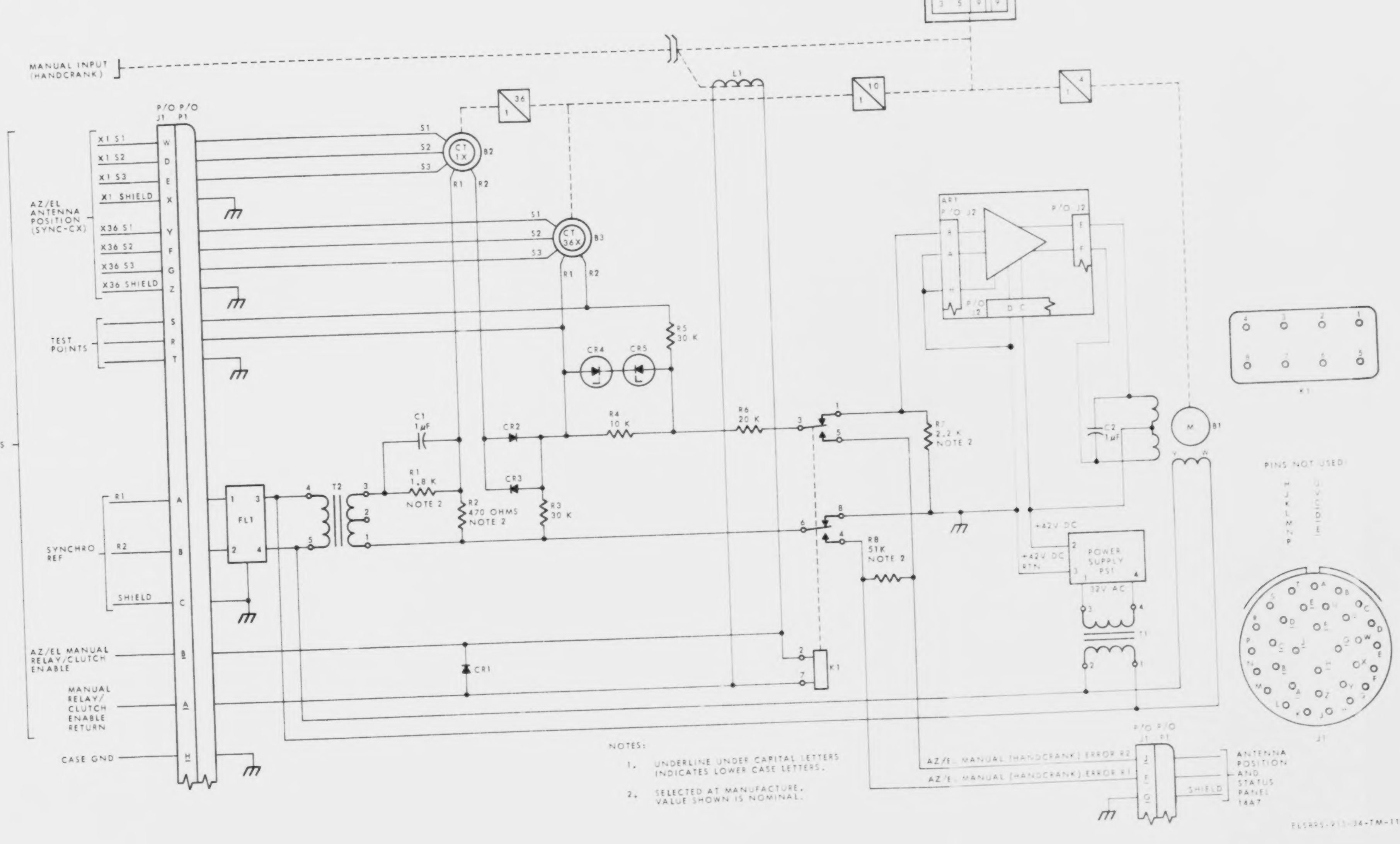
1. ONE AXIS SHOWN, TYPICAL FOR BOTH AXES.

Figure FO-5. Servo loop, functional block diagram.


J1
AUTOTRACK MODE STATUS
ACQUISITION MODE STATUS
SLAVE MODE STATUS
MANUAL MODE STATUS
STANDBY MODE STATUS
+26V DC
EL SLEW VELOCITY RTN
EL SLEW VELOCITY SHIELD
AZ SLEW VELOCITY RTN
+5V DC RTN
-15V DC
+15V DC
EL SERVO LIMIT STATUS
26V DC RTN
AZ SERVO LIMIT STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
S4
STANDBY
S3
MANUAL
S2
SLAVE
S1
ACQUISITION AUTOTRACK
EL SLEW
AZ SLEW
R1B
R1A
R2B
R2A
R1S1
R2S1
CW
CCW
CT
NC
NO
DS1
EL SERVO LIMIT
DS2
AZ SERVO LIMIT
P/O J1
MANUAL MODE COMMAND
SLAVE MODE COMMAND
ACQUISITION MODE COMMAND
STANDBY MODE COMMAND
EL SLEW VELOCITY
AZ SLEW VELOCITY SHIELD
AZ SLEW VELOCITY
AZ SLEW COMMAND
EL SLEW COMMAND
AZIMUTH INSTRUMENT SERVO A2
SYNCHRO REF SHIELD
SYNCHRO REF R2
SYNCHRO REF R1
AZIMUTH MANUAL (HANDCRANK) ERROR SHIELD
CASE GND
AZIMUTH MANUAL RELAY/CLUTCH ENABLE
AZIMUTH MANUAL RELAY/CLUTCH ENABLE RETURN
AZIMUTH ANTENNA POSITION (SYNCHRO-CX)
X1 SHIELD
X1 S1
X1 S2
X1 S3
X36 S1
X36 S2
X36 S3
X36 SHIELD
AZIMUTH MANUAL (HANDCRANK) ERROR R2
AZIMUTH MANUAL (HANDCRANK) ERROR R1
ELEVATION INSTRUMENT SERVO A1
ELEVATION MANUAL (HANDCRANK) ERROR SHIELD
ELEVATION MANUAL RELAY/CLUTCH ENABLE
ELEVATION MANUAL RELAY/CLUTCH ENABLE RTN
ELEVATION ANTENNA POSITION (SYNCHRO-CX)
ELEVATION MANUAL (HANDCRANK) ERROR R2
ELEVATION MANUAL (HANDCRANK) ERROR R1

NOTES:
1. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.

Figure FO-6. Antenna control panel 1A8, schematic diagram


DECIMAL COUNTER
3 5 9 9
MANUAL INPUT (HANDCRANK)
L1
1 36
1 10
1 4
P/O P/O
J1 P1
X1 S1
X1 S2
X1 S3
X1 SHIELD
X36 S1
X36 S2
X36 S3
X36 SHIELD
AZ/EL ANTENNA POSITION (SYNC-CX)
TEST POINTS
ANTENNA POSITION AND STATUS PANEL 14A7
SYNCHRO REF
R1
R2
SHIELD
AZ/EL MANUAL RELAY/CLUTCH ENABLE
MANUAL RELAY/ CLUTCH ENABLE RETURN
CASE GND
W
D
E
X
Y
F
G
Z
S
R
T
A
B
C
B
A
H
S1
S2
S3
CT 1X
B2
R1
R2
CT 36X
B3
R5 30 K
CR4
CR5
C1 1µF
CR2
CR3
R4 10 K
R6 20 K
R1 1.8 K NOTE 2
R2 470 OHMS NOTE 2
R3 30 K
FL1
T2
CR1
K1
R7 2.2 K NOTE 2
R8 51K NOTE 2
AR1
P/O J2
E
F
D C
C2 1µF
M
B1
+42V DC
+42V DC RTN
POWER SUPPLY PS1
32V AC
T1
K1
PINS NOT USED:
H J K L M N P
U V C D E
J1
AZ/EL MANUAL (HANDCRANK) ERROR R2
AZ/EL MANUAL (HANDCRANK) ERROR R1
SHIELD
ANTENNA POSITION AND STATUS PANEL 14A7
EL5895-915-34-TM-11

NOTES:

1. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.

2. SELECTED AT MANUFACTURE. VALUE SHOWN IS NOMINAL.

Figure FO-7. Instrument servo assembly 14A8A1, A8A2, schematic diagram.

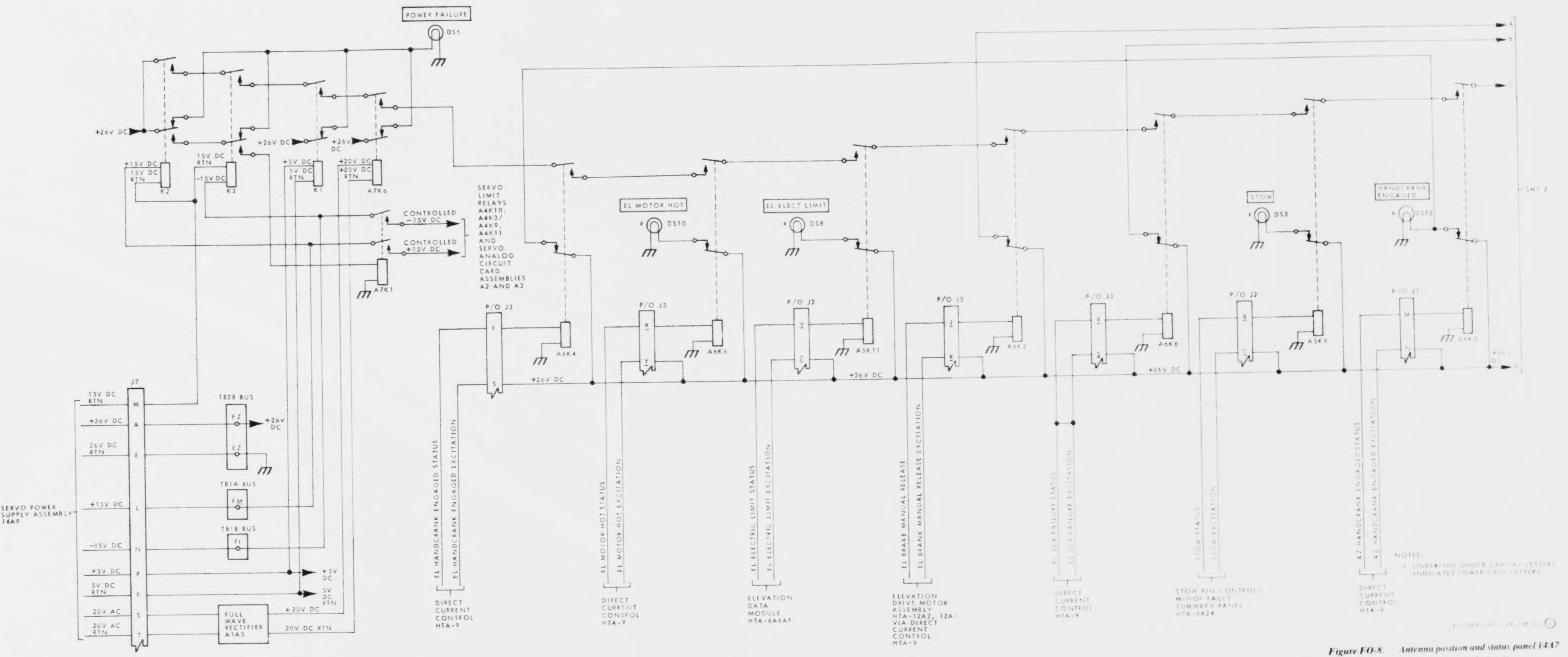

POWER FAILURE
DS5
+26V DC
+15V DC
15V DC RTN
K2
15V DC RTN
-15V DC
K3
+5V DC
5V DC RTN
K1
+20V DC
+20V DC RTN
A7K6
CONTROLLED -15V DC
CONTROLLED +15V DC
A7K1
SERVO LIMIT RELAYS A4K10, A4K3/ A4K9, A4K11 AND SERVO ANALOG CIRCUIT CARD ASSEMBLIES A2 AND A3
J7
SERVO POWER SUPPLY ASSEMBLY 14A9
20V AC
20V AC RTN
TB2B BUS
TB1A BUS
TB1B BUS
FULL WAVE RECTIFIER A1A5
+20V DC
20V DC RTN
EL MOTOR HOT
DS10
EL ELECT LIMIT
DS8
STOW
DS3
HANDCRANK ENGAGED
DS12
P/O J3
P/O J2
P/O J1
A6K4
A6K6
A5K11
A6K2
A6K8
A5K9
A6K3
+26V DC
EL HANDCRANK ENGAGED STATUS
EL HANDCRANK ENGAGED EXCITATION
DIRECT CURRENT CONTROL HTA-9
EL MOTOR HOT STATUS
EL MOTOR HOT EXCITATION
DIRECT CURRENT CONTROL HTA-9
EL ELECTRIC LIMIT STATUS
EL ELECTRIC LIMIT EXCITATION
ELEVATION DATA MODULE HTA-6A6A1
EL BRAKE MANUAL RELEASE
EL BRAKE MANUAL RELEASE EXCITATION
ELEVATION DRIVE MOTOR ASSEMBLY HTA-12A2, 12A1 VIA DIRECT CURRENT CONTROL HTA-9
EL SCR FAILURE STATUS
EL SCR FAILURE EXCITATION
DIRECT CURRENT CONTROL HTA-9
STOW STATUS
STOW EXCITATION
STOW PIN CONTROL/ MINOR FAULT SUMMARY PANEL HTA-8A24
A2 HANDCRANK ENGAGED STATUS
A2 HANDCRANK ENGAGED EXCITATION
DIRECT CURRENT CONTROL HTA-9
SHT 2
NOTES:
1. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS

Figure FO-8. *Antenna position and status panel 14A7 fault status and interlock circuits, simplified schematic diagram (sheet 1 of 2).*

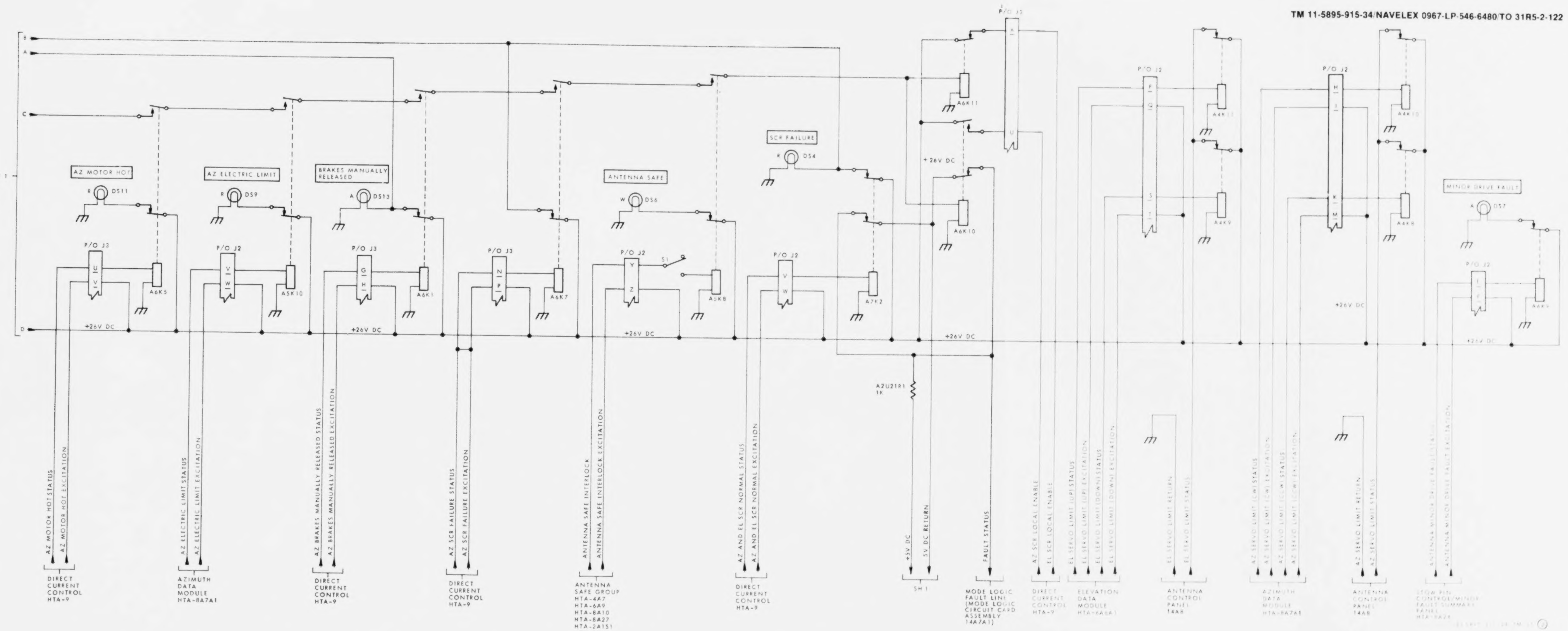

B
A
C
D
SH 1
AZ MOTOR HOT
R
DS11
P/O J3
U
V
A6K5
+26V DC
AZ ELECTRIC LIMIT
R
DS9
P/O J2
V
W
A5K10
BRAKES MANUALLY RELEASED
A
DS13
P/O J3
G
H
A6K1
+26V DC
P/O J3
N
P
A6K7
ANTENNA SAFE
W
DS6
P/O J2
Y
Z
S1
A5K8
+26V DC
SCR FAILURE
R
DS4
P/O J2
V
W
A7K2
P/O J3
A
U
A6K11
+26V DC
A6K10
A2U21R1
1K
+26V DC
P/O J2
P
Q
S
T
A4K11
A4K9
P/O J2
H
J
K
M
A4K10
A4K8
+26V DC
MINOR DRIVE FAULT
A
DS7
P/O J2
A6K9
+26V DC
AZ MOTOR HOT STATUS
AZ MOTOR HOT EXCITATION
DIRECT CURRENT CONTROL HTA-9
AZ ELECTRIC LIMIT STATUS
AZ ELECTRIC LIMIT EXCITATION
AZIMUTH DATA MODULE HTA-8A7A1
AZ BRAKES MANUALLY RELEASED STATUS
AZ BRAKES MANUALLY RELEASED EXCITATION
DIRECT CURRENT CONTROL HTA-9
AZ SCR FAILURE STATUS
AZ SCR FAILURE EXCITATION
DIRECT CURRENT CONTROL HTA-9
ANTENNA SAFE INTERLOCK
ANTENNA SAFE INTERLOCK EXCITATION
ANTENNA SAFE GROUP HTA-4A7 HTA-6A9 HTA-8A10 HTA-8A27 HTA-2A1S1 HTA-P201
AZ AND EL SCR NORMAL STATUS
AZ AND EL SCR NORMAL EXCITATION
DIRECT CURRENT CONTROL HTA-9
+5V DC
5V DC RETURN
SH 1
FAULT STATUS
MODE LOGIC FAULT LINE (MODE LOGIC CIRCUIT CARD ASSEMBLY 14A7A1)
AZ SCR LOCAL ENABLE
EL SCR LOCAL ENABLE
DIRECT CURRENT CONTROL HTA-9
EL SERVO LIMIT (UP) STATUS
EL SERVO LIMIT (UP) EXCITATION
EL SERVO LIMIT (DOWN) STATUS
EL SERVO LIMIT (DOWN) EXCITATION
ELEVATION DATA MODULE HTA-6A6A1
EL SERVO LIMIT RETURN
EL SERVO LIMIT STATUS
ANTENNA CONTROL PANEL 14A8
AZ SERVO LIMIT (CW) STATUS
AZ SERVO LIMIT (CW) EXCITATION
AZ SERVO LIMIT (CCW) STATUS
AZ SERVO LIMIT (CCW) EXCITATION
AZIMUTH DATA MODULE HTA-8A7A1
AZ SERVO LIMIT RETURN
AZ SERVO LIMIT STATUS
ANTENNA CONTROL PANEL 14A8
ANTENNA MINOR DRIVE FAULT STATUS
ANTENNA MINOR DRIVE FAULT EXCITATION
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24

Figure FO-8. Antenna position and status panel 14A7 fault status and interlock circuits, simplified schematic diagram (sheet 2 of 2).

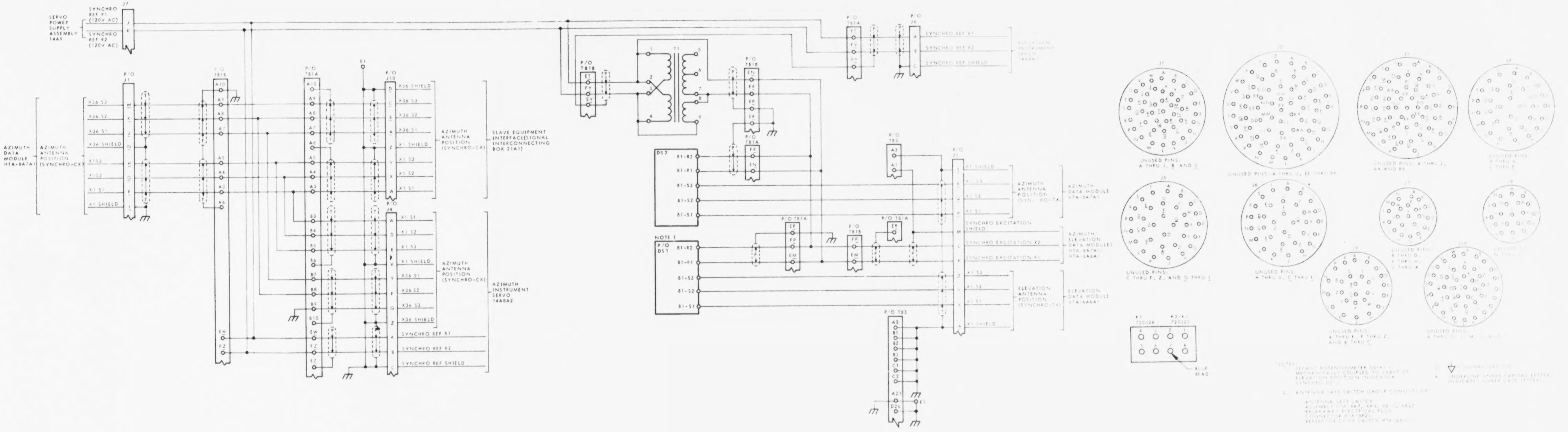

SERVO POWER SUPPLY ASSEMBLY 14A9
SYNCHRO REF R1 (120V AC)
SYNCHRO REF R2 (120V AC)
P/O J7
P/O J1
P/O TB1B
P/O TB1A
E1
P/O J10
P/O J4
AZIMUTH DATA MODULE HTA-8A7A1
AZIMUTH ANTENNA POSITION (SYNCHRO-CX)
X36 S3
X36 S2
X36 S1
X36 SHIELD
X1 S3
X1 S2
X1 S1
X1 SHIELD
SLAVE EQUIPMENT INTERFACE(SIGNAL INTERCONNECTING BOX 21A1)
AZIMUTH INSTRUMENT SERVO 14A8A2
SYNCHRO REF R1
SYNCHRO REF R2
SYNCHRO REF SHIELD
T1
P/O J6
ELEVATION INSTRUMENT SERVO
DS2
NOTE 1
P/O DS1
B1-R2
B1-R1
B1-S3
B1-S2
B1-S1
P/O TB3
SYNCHRO EXCITATION SHIELD
SYNCHRO EXCITATION R2
SYNCHRO EXCITATION R1
AZIMUTH ANTENNA POSITION (SYNCHRO-TX)
AZIMUTH DATA MODULE HTA-8A7A1
AZIMUTH/ELEVATION DATA MODULES HTA-8A7A1/HTA-6A6A1
ELEVATION ANTENNA POSITION (SYNCHRO-TX)
ELEVATION DATA MODULE HTA-6A6A1
UNUSED PINS

Figure FO-8. Antenna position and status panel 1A17, schematic diagram (sheet 1 of 5).

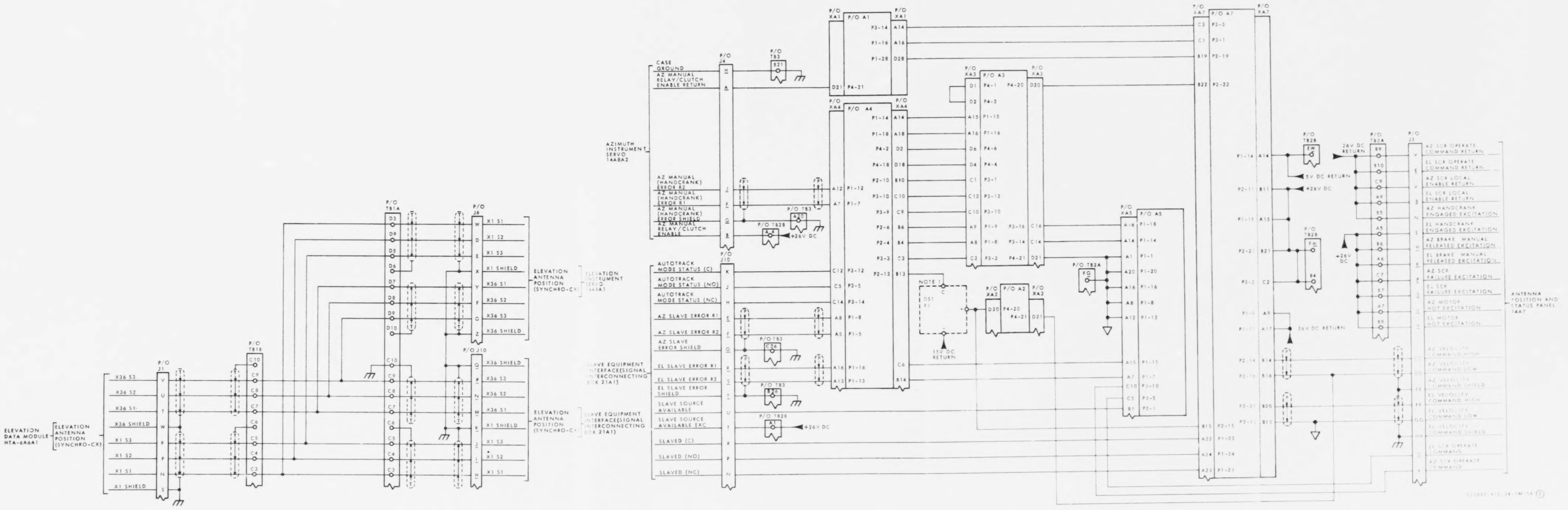
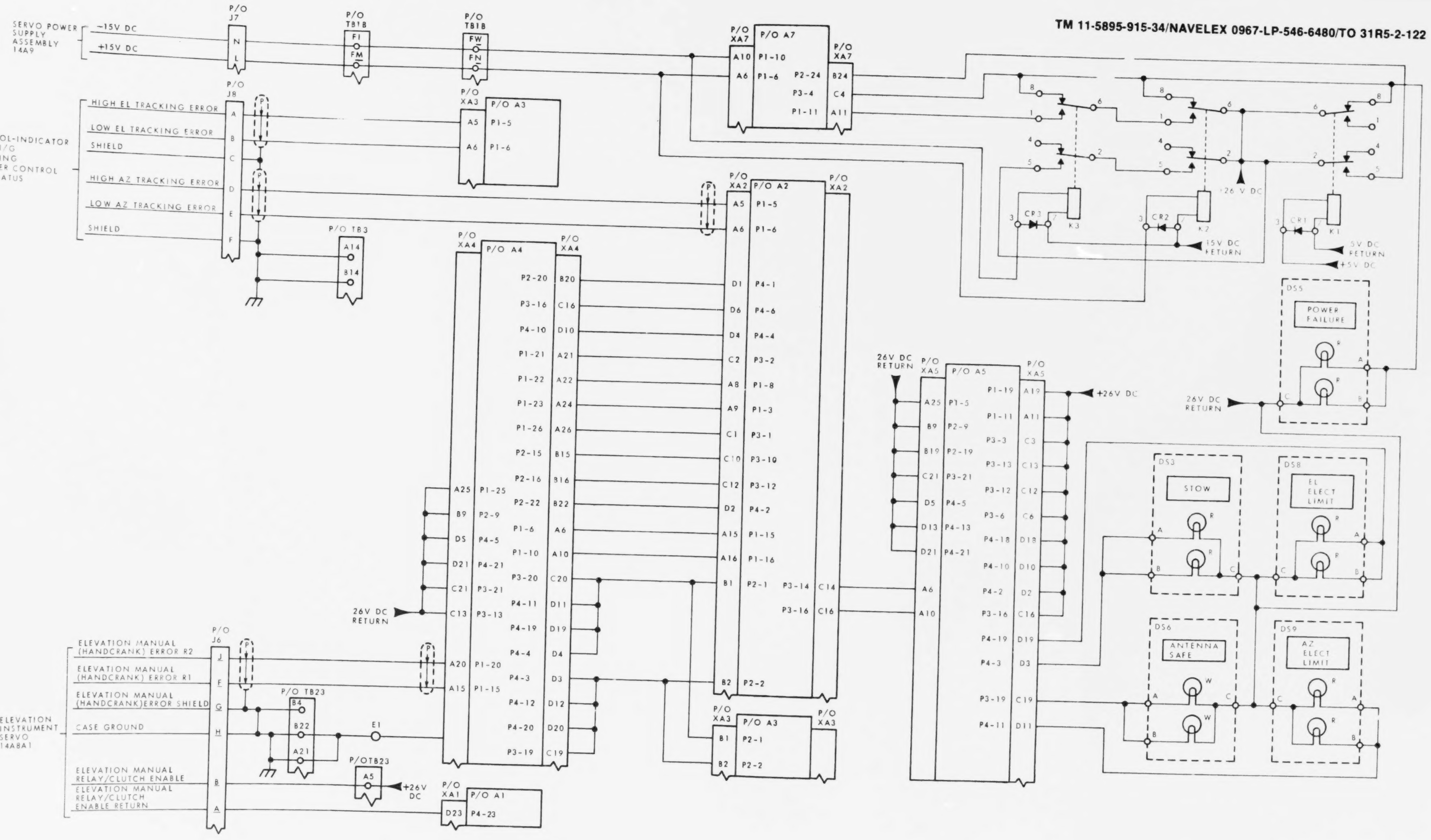

ELEVATION DATA MODULE HTA-6A6A1
ELEVATION ANTENNA POSITION (SYNCHRO-CX)
X36 S3
X36 S2
X36 S1
X36 SHIELD
X1 S3
X1 S2
X1 S1
X1 SHIELD
P/O J1
P/O TB1B
P/O TB1A
P/O J6
P/O J10
ELEVATION ANTENNA POSITION (SYNCHRO-CX)
ELEVATION INSTRUMENT SERVO 14A8A1
SLAVE EQUIPMENT INTERFACE(SIGNAL INTERCONNECTING BOX 21A1)
AZIMUTH INSTRUMENT SERVO 14A8A2
CASE GROUND
AZ MANUAL RELAY/CLUTCH ENABLE RETURN
AZ MANUAL (HANDCRANK) ERROR R2
AZ MANUAL (HANDCRANK) ERROR R1
AZ MANUAL (HANDCRANK) ERROR SHIELD
AZ MANUAL RELAY/CLUTCH ENABLE
AUTOTRACK MODE STATUS (C)
AUTOTRACK MODE STATUS (NO)
AUTOTRACK MODE STATUS (NC)
AZ SLAVE ERROR R1
AZ SLAVE ERROR R2
AZ SLAVE ERROR SHIELD
EL SLAVE ERROR R1
EL SLAVE ERROR R2
EL SLAVE ERROR SHIELD
SLAVE SOURCE AVAILABLE
SLAVE SOURCE AVAILABLE EXC
SLAVED (C)
SLAVED (NO)
SLAVED (NC)
P/O J4
P/O TB3
P/O TB2B
+26V DC
P/O XA1
P/O A1
P/O XA4
P/O A4
P/O XA3
P/O A3
P/O XA5
P/O A5
P/O XA2
P/O A2
NOTE 1
DS1
28V DC RETURN
P/O XA7
P/O A7
28V DC RETURN
+26V DC
P/O TB2A
P/O J3
AZ SCR OPERATE COMMAND RETURN
EL SCR OPERATE COMMAND RETURN
AZ SCR LOCAL ENABLE RETURN
EL SCR LOCAL ENABLE RETURN
AZ HANDCRANK ENGAGED EXCITATION
EL HANDCRANK ENGAGED EXCITATION
AZ BRAKE MANUAL RELEASED EXCITATION
EL BRAKE MANUAL RELEASED EXCITATION
AZ SCR FAILURE EXCITATION
EL SCR FAILURE EXCITATION
AZ MOTOR HOT EXCITATION
EL MOTOR HOT EXCITATION
AZ VELOCITY COMMAND HIGH
AZ VELOCITY COMMAND LOW
AZ VELOCITY COMMAND SHIELD
EL VELOCITY COMMAND HIGH
EL VELOCITY COMMAND LOW
EL VELOCITY COMMAND SHIELD
EL SCR OPERATE COMMAND
AZ SCR OPERATE COMMAND
ANTENNA POSITION AND STATUS PANEL 14A7
EL5895-915-34-TM-56 (2)

Figure FO-9. Antenna position and status panel 14A7, schematic diagram (sheet 2 of 5).


SERVO POWER SUPPLY ASSEMBLY 14A9
-15V DC
+15V DC
P/O J7
P/O TB1B
P/O J8
HIGH EL TRACKING ERROR
LOW EL TRACKING ERROR
SHIELD
HIGH AZ TRACKING ERROR
LOW AZ TRACKING ERROR
SHIELD
CONTROL-INDICATOR ID-1911/G (TRACKING RECEIVER CONTROL AND STATUS PANEL 14A6)
P/O TB3
P/O XA3
P/O A3
P/O XA7
P/O A7
P/O XA2
P/O A2
P/O XA4
P/O A4
P/O XA5
P/O A5
P/O XA1
P/O A1
26V DC RETURN
+26V DC
+26 V DC
15V DC RETURN
5V DC RETURN
+5V DC
K1
K2
K3
CR1
CR2
CR3
DS5
POWER FAILURE
DS3
STOW
DS8
EL ELECT LIMIT
DS6
ANTENNA SAFE
DS9
AZ ELECT LIMIT
P/O J6
ELEVATION MANUAL (HANDCRANK) ERROR R2
ELEVATION MANUAL (HANDCRANK) ERROR R1
ELEVATION MANUAL (HANDCRANK)ERROR SHIELD
CASE GROUND
ELEVATION MANUAL RELAY/CLUTCH ENABLE
ELEVATION MANUAL RELAY/CLUTCH ENABLE RETURN
ELEVATION INSTRUMENT SERVO 14A8A1
P/O TB23
P/OTB23
E1

EL5895-915-34-TM-56 ③

Figure FO-9. Antenna position and status panel 14A7, schematic diagram (sheet 3 of 5).

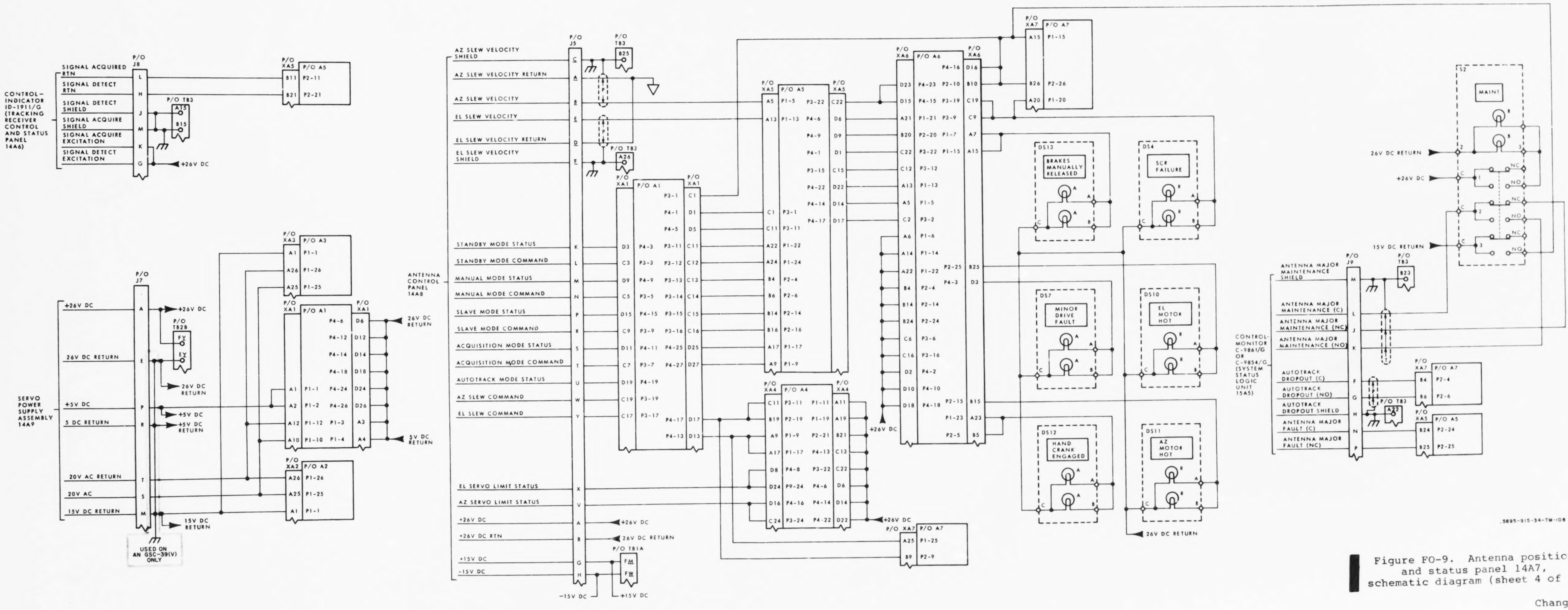

CONTROL-INDICATOR ID-1911/G (TRACKING RECEIVER CONTROL AND STATUS PANEL 14A6)
SIGNAL ACQUIRED RTN
SIGNAL DETECT RTN
SIGNAL DETECT SHIELD
SIGNAL ACQUIRE SHIELD
SIGNAL ACQUIRE EXCITATION
SIGNAL DETECT EXCITATION
P/O J8
P/O TB3
A15
B15
+26V DC
P/O XA5
P/O A5
B11 P2-11
B21 P2-21
SERVO POWER SUPPLY ASSEMBLY 14A9
+26V DC
26V DC RETURN
+5V DC
5 DC RETURN
20V AC RETURN
20V AC
15V DC RETURN
P/O J7
P/O TB2B
26V DC RETURN
+5V DC
+5V DC RETURN
15V DC RETURN
USED ON AN GSC-39(V) ONLY
P/O XA3
P/O A3
P/O XA1
P/O A1
P/O XA2
P/O A2
26V DC RETURN
5V DC RETURN
ANTENNA CONTROL PANEL 14A8
AZ SLEW VELOCITY SHIELD
AZ SLEW VELOCITY RETURN
AZ SLEW VELOCITY
EL SLEW VELOCITY
EL SLEW VELOCITY RETURN
EL SLEW VELOCITY SHIELD
STANDBY MODE STATUS
STANDBY MODE COMMAND
MANUAL MODE STATUS
MANUAL MODE COMMAND
SLAVE MODE STATUS
SLAVE MODE COMMAND
ACQUISITION MODE STATUS
ACQUISITION MODE COMMAND
AUTOTRACK MODE STATUS
AZ SLEW COMMAND
EL SLEW COMMAND
EL SERVO LIMIT STATUS
AZ SERVO LIMIT STATUS
+26V DC
+26V DC RTN
+15V DC
-15V DC
P/O J5
P/O TB3
B25
A26
+26V DC
26V DC RETURN
P/O TB1A
-15V DC
+15V DC
P/O XA5
P/O A5
P/O XA4
P/O A4
+26V DC
P/O XA6
P/O A6
P/O XA7
P/O A7
DS13
BRAKES MANUALLY RELEASED
DS4
SCR FAILURE
DS7
MINOR DRIVE FAULT
DS10
EL MOTOR HOT
DS12
HAND CRANK ENGAGED
DS11
AZ MOTOR HOT
26V DC RETURN
S2
MAINT
26V DC RETURN
+26V DC
15V DC RETURN
NC
NO
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
ANTENNA MAJOR MAINTENANCE SHIELD
ANTENNA MAJOR MAINTENANCE (C)
ANTENNA MAJOR MAINTENANCE (NC)
ANTENNA MAJOR MAINTENANCE (NO)
AUTOTRACK DROPOUT (C)
AUTOTRACK DROPOUT (NO)
AUTOTRACK DROPOUT SHIELD
ANTENNA MAJOR FAULT (C)
ANTENNA MAJOR FAULT (NC)
P/O J9
B23
A22
B4 P2-4
B6 P2-6
B24 P2-24
B25 P2-25
5895-915-34-TM-108

Figure FO-9. Antenna position and status panel 14A7, schematic diagram (sheet 4 of 5).

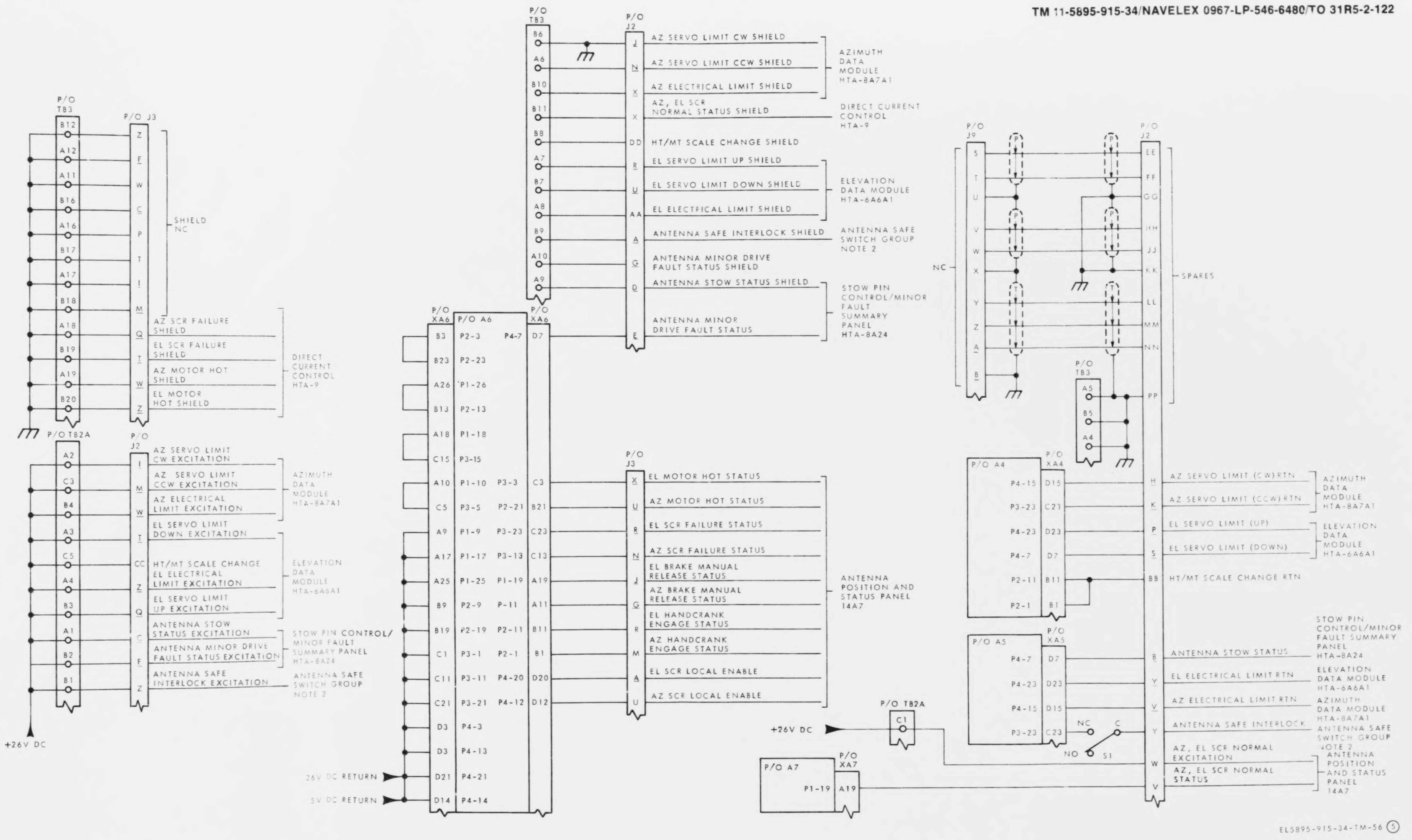

P/O TB3
P/O J3
SHIELD NC
AZ SCR FAILURE SHIELD
EL SCR FAILURE SHIELD
AZ MOTOR HOT SHIELD
EL MOTOR HOT SHIELD
DIRECT CURRENT CONTROL HTA-9
P/O TB2A
P/O J2
AZ SERVO LIMIT CW EXCITATION
AZ SERVO LIMIT CCW EXCITATION
AZ ELECTRICAL LIMIT EXCITATION
AZIMUTH DATA MODULE HTA-8A7A1
EL SERVO LIMIT DOWN EXCITATION
HT/MT SCALE CHANGE
EL ELECTRICAL LIMIT EXCITATION
EL SERVO LIMIT UP EXCITATION
ELEVATION DATA MODULE HTA-6A6A1
ANTENNA STOW STATUS EXCITATION
ANTENNA MINOR DRIVE FAULT STATUS EXCITATION
STOW PIN CONTROL/ MINOR FAULT SUMMARY PANEL HTA-8A24
ANTENNA SAFE INTERLOCK EXCITATION
ANTENNA SAFE SWITCH GROUP NOTE 2
+26V DC
P/O XA6
P/O A6
26V DC RETURN
5V DC RETURN
AZ SERVO LIMIT CW SHIELD
AZ SERVO LIMIT CCW SHIELD
AZ ELECTRICAL LIMIT SHIELD
AZIMUTH DATA MODULE HTA-8A7A1
AZ, EL SCR NORMAL STATUS SHIELD
DIRECT CURRENT CONTROL HTA-9
HT/MT SCALE CHANGE SHIELD
EL SERVO LIMIT UP SHIELD
EL SERVO LIMIT DOWN SHIELD
EL ELECTRICAL LIMIT SHIELD
ELEVATION DATA MODULE HTA-6A6A1
ANTENNA SAFE INTERLOCK SHIELD
ANTENNA SAFE SWITCH GROUP NOTE 2
ANTENNA MINOR DRIVE FAULT STATUS SHIELD
ANTENNA STOW STATUS SHIELD
ANTENNA MINOR DRIVE FAULT STATUS
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
EL MOTOR HOT STATUS
AZ MOTOR HOT STATUS
EL SCR FAILURE STATUS
AZ SCR FAILURE STATUS
EL BRAKE MANUAL RELEASE STATUS
AZ BRAKE MANUAL RELEASE STATUS
EL HANDCRANK ENGAGE STATUS
AZ HANDCRANK ENGAGE STATUS
EL SCR LOCAL ENABLE
AZ SCR LOCAL ENABLE
ANTENNA POSITION AND STATUS PANEL 14A7
P/O J9
NC
SPARES
P/O A4
P/O XA4
AZ SERVO LIMIT (CW) RTN
AZ SERVO LIMIT (CCW) RTN
AZIMUTH DATA MODULE HTA-8A7A1
EL SERVO LIMIT (UP)
EL SERVO LIMIT (DOWN)
ELEVATION DATA MODULE HTA-6A6A1
HT/MT SCALE CHANGE RTN
P/O A5
P/O XA5
ANTENNA STOW STATUS
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
EL ELECTRICAL LIMIT RTN
ELEVATION DATA MODULE HTA-6A6A1
AZ ELECTRICAL LIMIT RTN
AZIMUTH DATA MODULE HTA-8A7A1
ANTENNA SAFE INTERLOCK
ANTENNA SAFE SWITCH GROUP NOTE 2
NC
C
NO
S1
AZ, EL SCR NORMAL EXCITATION
AZ, EL SCR NORMAL STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
+26V DC
P/O A7
P/O XA7
P1-19
A19
EL5895-915-34-TM-56 ⑤

Figure FO-9. Antenna position and status panel 14A7, schematic diagram (sheet 5 of 5).

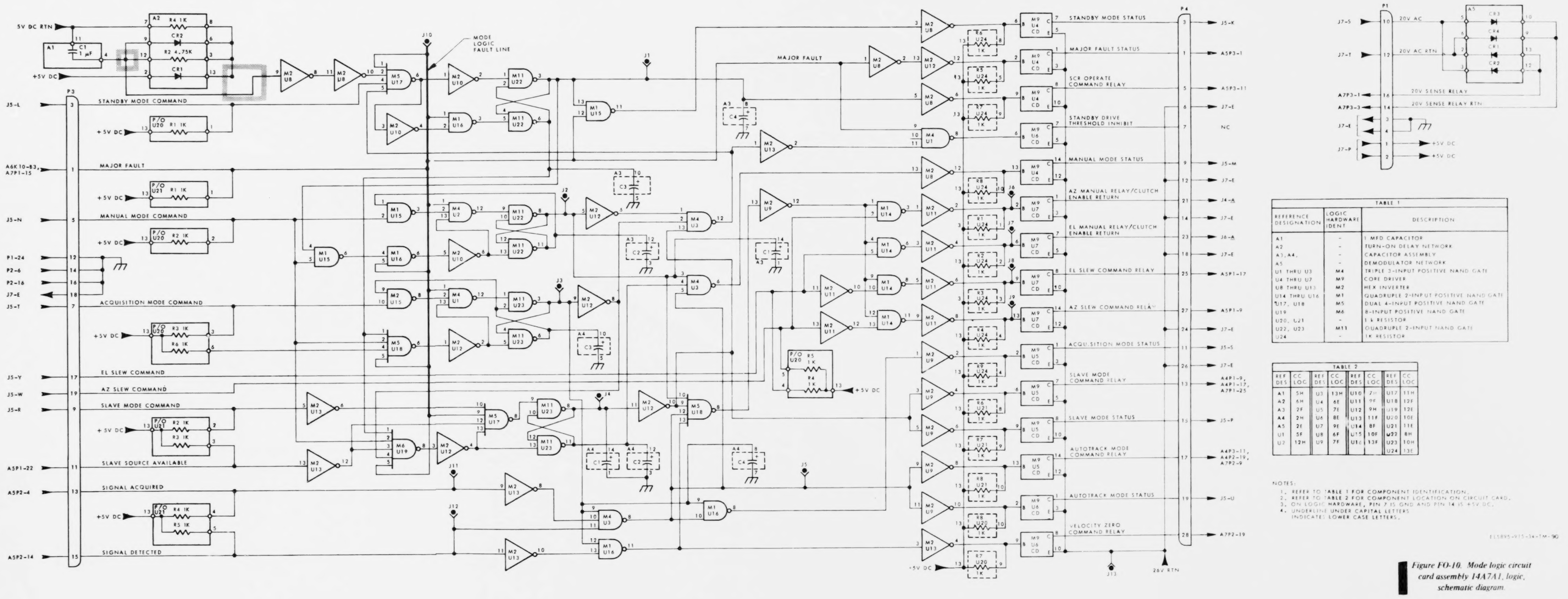
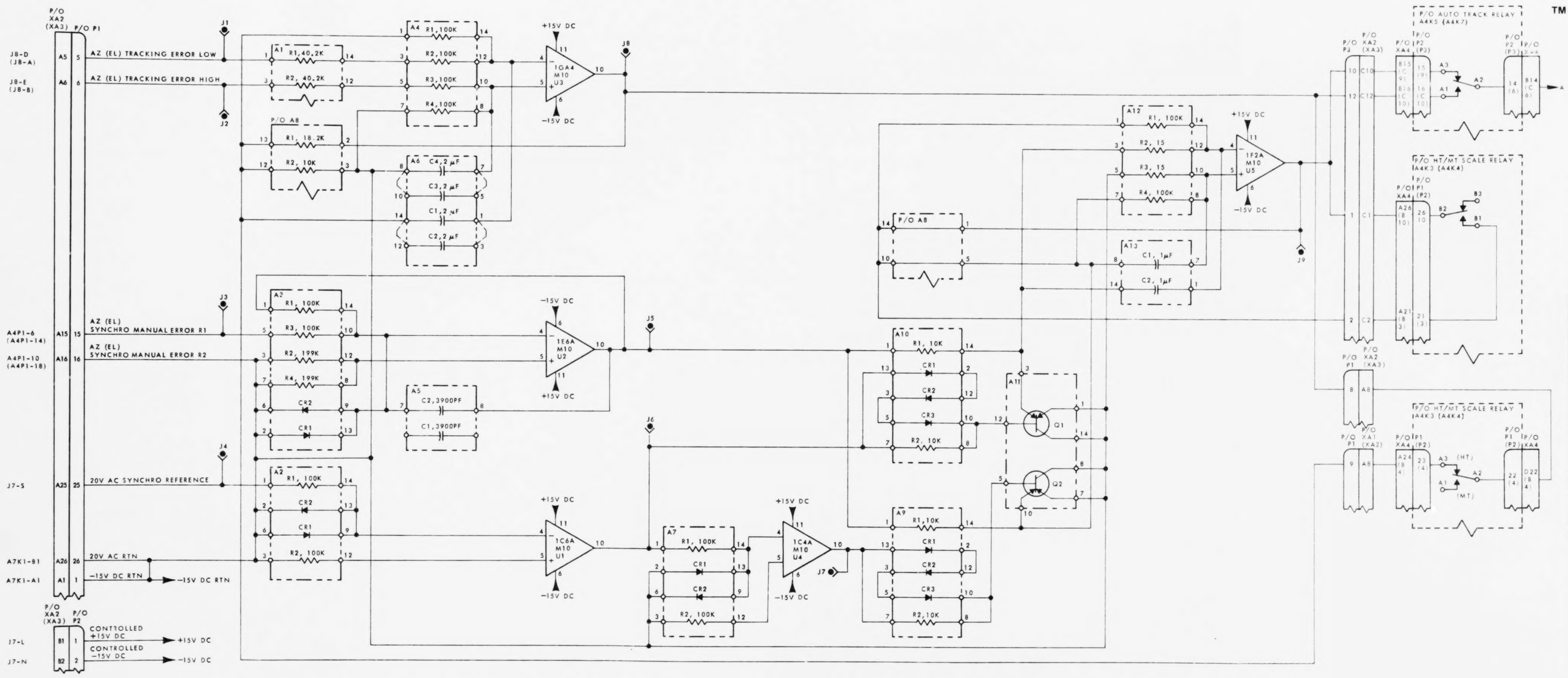

5V DC RTN
+5V DC
A1
C1 1 μF
A2
R4 1K
CR2
R2 4.75K
CR1
J10
MODE LOGIC FAULT LINE
P3
J5-L
STANDBY MODE COMMAND
P/O U20
R1 1K
A6K10-B3, A7P1-15
MAJOR FAULT
P/O U21
J5-N
MANUAL MODE COMMAND
R2 1K
P1-24
P2-6
P2-16
J7-E
J5-T
ACQUISITION MODE COMMAND
R3 1K
R6 1K
J5-Y
EL SLEW COMMAND
J5-W
AZ SLEW COMMAND
J5-R
SLAVE MODE COMMAND
R3 1K
A5P1-22
SLAVE SOURCE AVAILABLE
A5P2-4
SIGNAL ACQUIRED
R4 1K
R5 1K
A5P2-14
SIGNAL DETECTED
J1
J2
J3
J4
J5
J11
J12
MAJOR FAULT
A3
A4
C1
C2
C3
C4
P/O U20
R5 1K
R4 1K
+5V DC
P4
STANDBY MODE STATUS
J5-K
MAJOR FAULT STATUS
A5P3-1
SCR OPERATE COMMAND RELAY
A5P3-11
J7-E
STANDBY DRIVE THRESHOLD INHIBIT
NC
MANUAL MODE STATUS
J5-M
J6
AZ MANUAL RELAY/CLUTCH ENABLE RETURN
J4-A
J7
EL MANUAL RELAY/CLUTCH ENABLE RETURN
J6-A
J8
EL SLEW COMMAND RELAY
A5P1-17
J9
AZ SLEW COMMAND RELAY
A5P1-9
ACQUISITION MODE STATUS
J5-S
SLAVE MODE COMMAND RELAY
A4P1-9, A4P1-17, A7P1-25
SLAVE MODE STATUS
J5-P
AUTOTRACK MODE COMMAND RELAY
A4P3-11, A4P2-19, A7P2-9
AUTOTRACK MODE STATUS
J5-U
VELOCITY ZERO COMMAND RELAY
A7P2-19
J13
26V RTN
P1
J7-S
20V AC
J7-T
20V AC RTN
A5
CR1
CR2
CR3
CR4
A7P3-1
20V SENSE RELAY
A7P3-3
20V SENSE RELAY RTN
J7-P
+5V DC
EL5895-915-34-TM-90

TABLE 1		
REFERENCE DESIGNATION	LOGIC HARDWARE IDENT	DESCRIPTION
A1	-	1 MFD CAPACITOR
A2	-	TURN-ON DELAY NETWORK
A3, A4,	-	CAPACITOR ASSEMBLY
A5	-	DEMODULATOR NETWORK
U1 THRU U3	M4	TRIPLE 3-INPUT POSITIVE NAND GATE
U4 THRU U7	M9	CORE DRIVER
U8 THRU U13	M2	HEX INVERTER
U14 THRU U16	M1	QUADRUPLE 2-INPUT POSITIVE NAND GATE
U17, U18	M5	DUAL 4-INPUT POSITIVE NAND GATE
U19	M6	8-INPUT POSITIVE NAND GATE
U20, U21	-	1 k RESISTOR
U22, U23	M11	QUADRUPLE 2-INPUT NAND GATE
U24	-	1K RESISTOR

TABLE 2							
REF DES	CC LOC	REF DES	CC LOC	REF DES	CC LOC	REF DES	CC LOC
A1	5H	U3	13H	U10	7H	U17	11H
A2	6H	U4	6E	U11	9F	U18	12F
A3	2F	U5	7E	U12	9H	U19	12E
A4	2H	U6	8E	U13	11F	U20	10E
A5	2E	U7	9E	U14	8F	U21	11E
U1	5F	U8	6F	U15	10F	U22	8H
U2	12H	U9	7F	U16	13F	U23	10H
						U24	13E

NOTES:
1. REFER TO TABLE 1 FOR COMPONENT IDENTIFICATION.
2. REFER TO TABLE 2 FOR COMPONENT LOCATION ON CIRCUIT CARD.
3. ON LOGIC HARDWARE, PIN 7 IS GND AND PIN 14 IS +5V DC.
4. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.

Figure FO-10. Mode logic circuit card assembly 14A7A1, logic, schematic diagram.


P/O XA2 (XA3)
P/O P1
J8-D (J8-A)
J8-E (J8-B)
A5
A6
AZ (EL) TRACKING ERROR LOW
AZ (EL) TRACKING ERROR HIGH
J1
J2
A1
R1, 40.2K
R2, 40.2K
P/O A8
R1, 18.2K
R2, 10K
A4
R1, 100K
R2, 100K
R3, 100K
R4, 100K
A6
C4, 2 µF
C3, 2 µF
C1, 2 µF
C2, 2 µF
+15V DC
-15V DC
1GA4
M10
U3
J8
A4P1-6 (A4P1-14)
A4P1-10 (A4P1-18)
A15
A16
AZ (EL) SYNCHRO MANUAL ERROR R1
AZ (EL) SYNCHRO MANUAL ERROR R2
J3
A3
R1, 100K
R3, 100K
R2, 199K
R4, 199K
CR2
CR1
A5
C2, 3900PF
C1, 3900PF
1E6A
M10
U2
J5
J4
J7-5
A25
20V AC SYNCHRO REFERENCE
A2
R1, 100K
R2, 100K
1C6A
M10
U1
A7K1-B1
A7K1-A1
A26
A1
20V AC RTN
-15V DC RTN
J7-L
J7-N
B1
B2
P/O P2
CONTROLLED +15V DC
CONTROLLED -15V DC
J6
A7
R1, 100K
R2, 100K
1C4A
M10
U4
J7
A10
R1, 10K
R2, 10K
CR3
A9
A11
Q1
Q2
P/O A8
A12
R1, 100K
R2, 15
R3, 15
R4, 100K
A13
C1, 1µF
C2, 1µF
1F2A
M10
U5
J9
P/O P3
P/O XA2 (XA3)
P/O XA4
P/O AUTO TRACK RELAY A4K5 (A4K7)
A SHEET 2
P/O HT/MT SCALE RELAY A4K3 (A4K4)
(HT)
(MT)
P/O XA1 (XA2)

NOTES:

1. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.
2. ON LOGIC HARDWARE, PIN 7 IS GROUND AND PIN 14 IS +5 V
3. CONNECTOR AND RELAY DESIGNATIONS FOR THE ELEVATION SERVO ANALOG CIRCUIT CARD ASSEMBLY (A3) ARE GIVEN IN PARENTHESIS WHEN NOT THE SAME AS THE AZIMUTH SERVO ANALOG CIRCUIT CARD ASSEMBLY (A2)
4. REFER TO TABLE 1 FOR COMPONENT IDENTIFICATION
5. REFER TO TABLE 2 FOR COMPONENT LOCATION ON CIRCUIT CARD
6. APPLIES TO AZIMUTH SERVO ANALOG CIRCUIT CARD ASSEMBLY ONLY
7. APPLIES TO ELEVATION SERVO ANALOG CIRCUIT CARD ASSEMBLY ONLY

TABLE 1 CIRCUIT CARD COMPONENT IDENTIFICATION

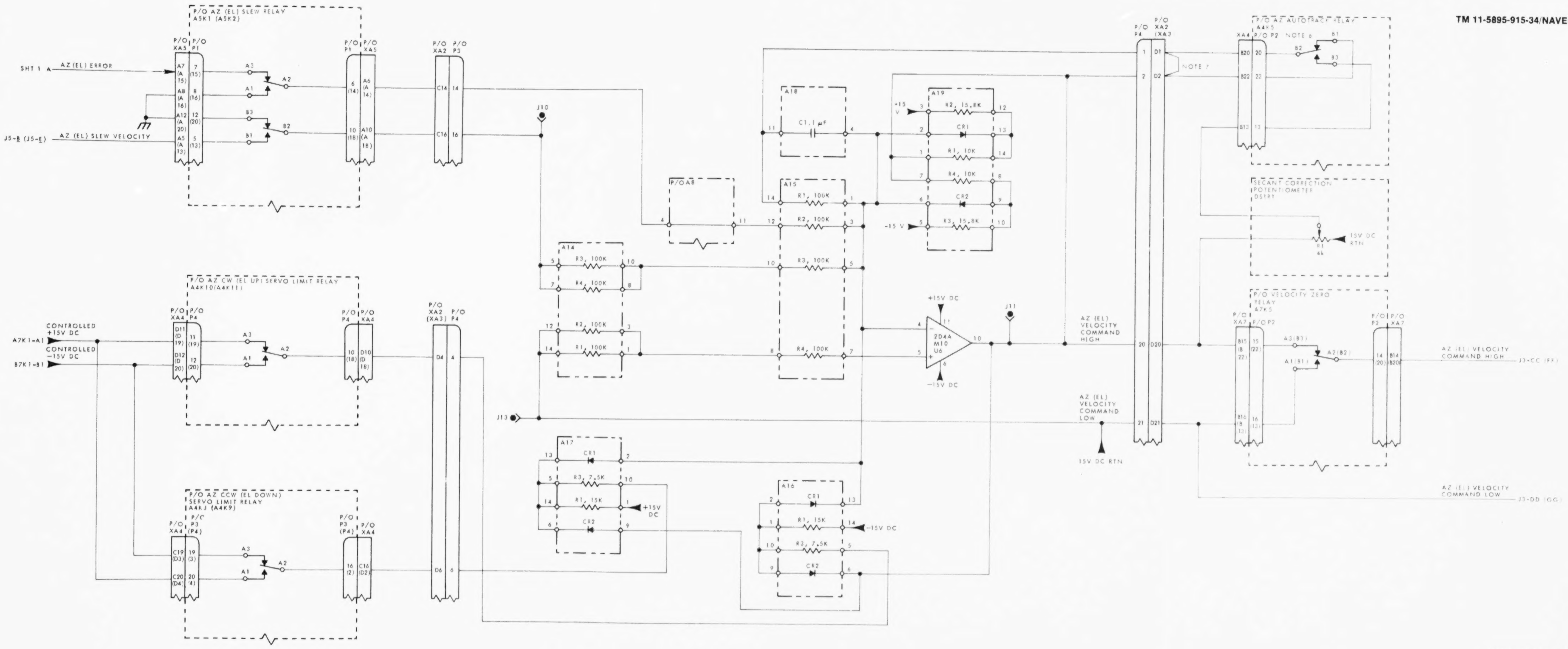
REFERENCE DESIGNATION	LOGIC IDENTIFICATION	DESCRIPTION
A1 THRU A4, A7, A12, A14, A15	—	UNITY GAIN NETWORK
A5	—	3900µF CAPACITOR
A6, A13	—	0.1µF SCALING NETWORK
A8	—	GAIN SCALING NETWORK
A9, A10	—	DEMODULATOR NETWORK
A11	—	DEMODULATOR SWITCH
A16, A17	—	SERVO LIMIT NETWORK
A18	—	1µF CAPACITOR
A19	—	10 VOLT LIMIT NETWORK
U1 THRU U6	M10	OPERATIONAL AMPLIFIER

TABLE 2 CIRCUIT CARD COMPONENT LOCATION

REF DES	LOC	REF DES	LOC	REF DES	LOC	REF DES	LOC	REF DES	LOC	REF DES	LOC
A1	2H	A5	5F	A9	8E	A13	10H	A17	13H	U2	4F
A2	3E	A6	5H	A10	8F	A14	12E	A18	14F	U3	4H
A3	3F	A7	6E	A11	9F	A15	12F	A19	14H	J4	7E
A4	3H	A8	6H	A12	10F	A16	12H	U1	14F	U5	11F
										U6	13F

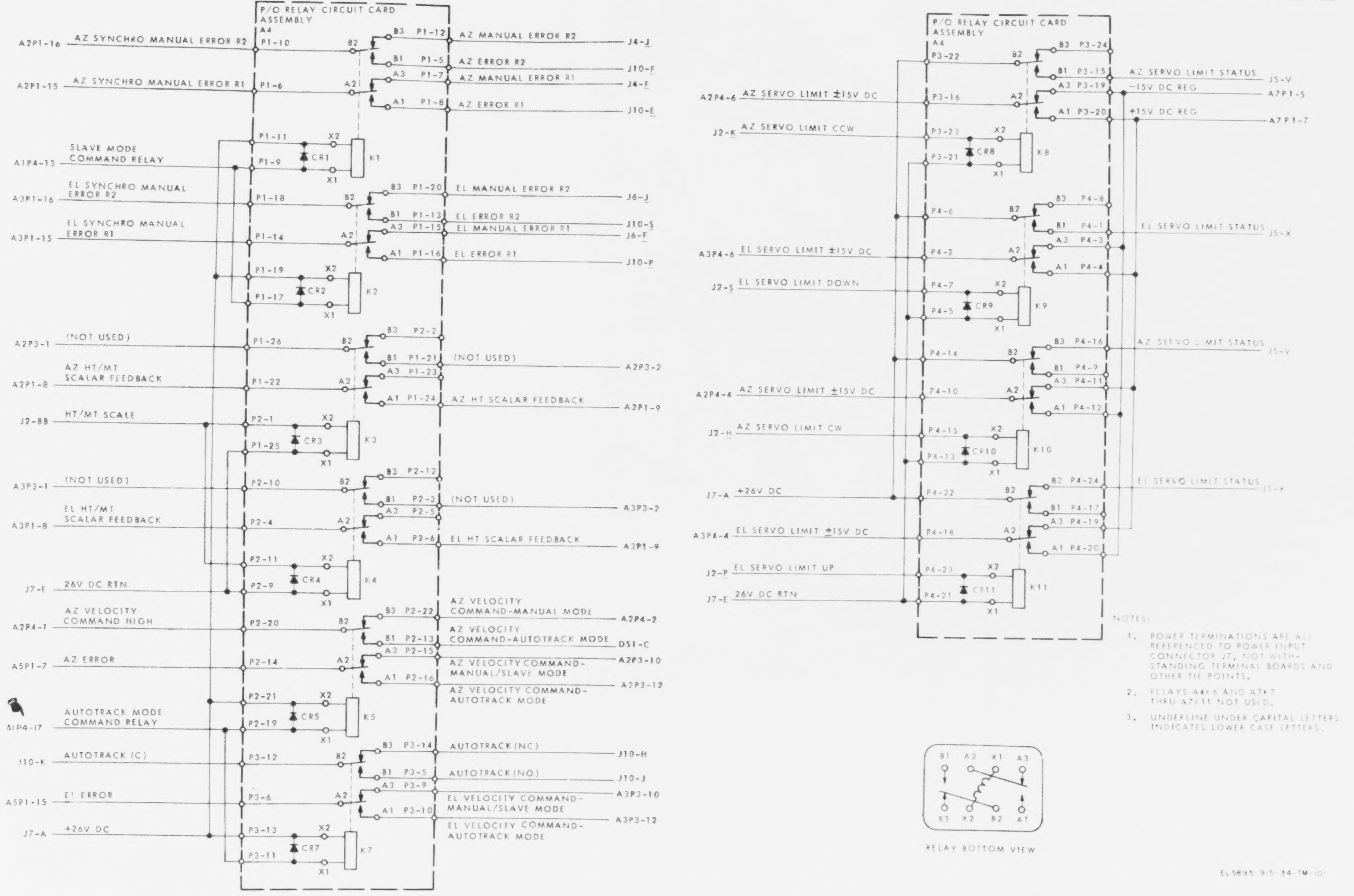
EL5895-915-34-TM-58 ①

Figure FO-11. Servo analog circuit card assembly 14A7A2, A7A3, schematic diagram (sheet 1 of 2).


P/O AZ (EL) SLEW RELAY A5K1 (A5K2)
SHT 1 A
AZ (EL) ERROR
J5-B (J5-E)
AZ (EL) SLEW VELOCITY
P/O XA5
P/O P1
P/O XA2
P/O P3
J10
P/O AZ CW (EL UP) SERVO LIMIT RELAY A4K10(A4K11)
CONTROLLED +15V DC
CONTROLLED −15V DC
A7K1-A1
B7K1-B1
P/O XA4
P/O P4
P/O XA2 (XA3)
P/O AZ CCW (EL DOWN) SERVO LIMIT RELAY A4KJ (A4K9)
J13
P/O A8
A14
R3, 100K
R4, 100K
R2, 100K
R1, 100K
A18
C1, 1 μF
A15
A19
+15 V
R2, 15.8K
CR1
R1, 10K
R4, 10K
CR2
−15 V
R3, 15.8K
+15V DC
2D4A
M10
U6
−15V DC
J11
A17
R3, 7.5K
R1, 15K
+15V DC
A16
−15V DC
AZ (EL) VELOCITY COMMAND HIGH
AZ (EL) VELOCITY COMMAND LOW
15V DC RTN
NOTE 7
P/O AZ AUTOTRACK RELAY A4K5
NOTE 6
SECANT CORRECTION POTENTIOMETER DS1R1
R1 4k
15V DC RTN
P/O VELOCITY ZERO RELAY A7K5
P/O XA7
P/O P2
A3(B3)
A2(B2)
A1(B1)
AZ (EL) VELOCITY COMMAND HIGH
J3-CC (FF)
AZ (EL) VELOCITY COMMAND LOW
J3-DD (GG)

EL5895-915-34-TM-58 ②

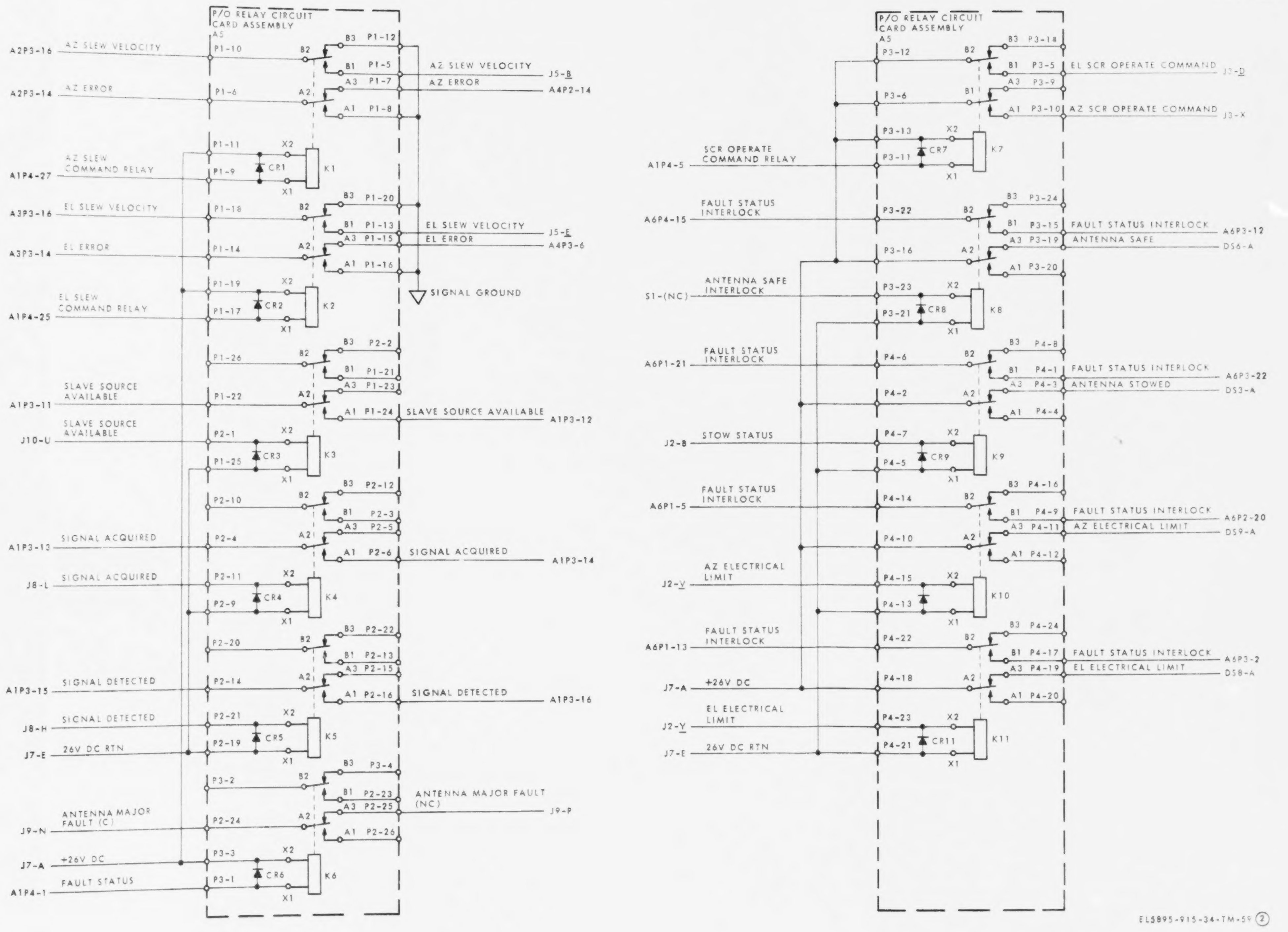
Figure FO-11. Servo analog circuit card assembly 14A7A2, A7A3, schematic diagram (sheet 2 of 2).


P/O RELAY CIRCUIT CARD ASSEMBLY A4
A2P1-16
AZ SYNCHRO MANUAL ERROR R2
A2P1-15
AZ SYNCHRO MANUAL ERROR R1
A1P4-13
SLAVE MODE COMMAND RELAY
A3P1-16
EL SYNCHRO MANUAL ERROR R2
A3P1-15
EL SYNCHRO MANUAL ERROR R1
A2P3-1
(NOT USED)
A2P1-8
AZ HT/MT SCALAR FEEDBACK
J2-BB
HT/MT SCALE
A3P3-1
(NOT USED)
A3P1-8
EL HT/MT SCALAR FEEDBACK
J7-E
26V DC RTN
A2P4-1
AZ VELOCITY COMMAND HIGH
A5P1-7
AZ ERROR
A1P4-17
AUTOTRACK MODE COMMAND RELAY
J10-K
AUTOTRACK (C)
A5P1-15
El ERROR
J7-A
+26V DC
K1
K2
K3
K4
K5
K7
CR1
CR2
CR3
CR4
CR5
CR7
AZ MANUAL ERROR R2
J4-J
AZ ERROR R2
J10-F
AZ MANUAL ERROR R1
J4-F
AZ ERROR R1
J10-E
EL MANUAL ERROR R2
J6-J
EL ERROR R2
J10-S
EL MANUAL ERROR R1
J6-F
EL ERROR R1
J10-P
(NOT USED)
A2P3-2
AZ HT SCALAR FEEDBACK
A2P1-9
(NOT USED)
A3P3-2
EL HT SCALAR FEEDBACK
A3P1-9
AZ VELOCITY COMMAND-MANUAL MODE
A2P4-2
AZ VELOCITY COMMAND-AUTOTRACK MODE
DS1-C
AZ VELOCITY COMMAND-MANUAL/SLAVE MODE
A2P3-10
AZ VELOCITY COMMAND-AUTOTRACK MODE
A2P3-12
AUTOTRACK(NC)
J10-H
AUTOTRACK(NO)
J10-J
EL VELOCITY COMMAND-MANUAL/SLAVE MODE
A3P3-10
EL VELOCITY COMMAND-AUTOTRACK MODE
A3P3-12
P/O RELAY CIRCUIT CARD ASSEMBLY A4
A2P4-6
AZ SERVO LIMIT ±15V DC
J2-K
AZ SERVO LIMIT CCW
A3P4-6
EL SERVO LIMIT ±15V DC
J2-S
EL SERVO LIMIT DOWN
A2P4-4
AZ SERVO LIMIT ±15V DC
J2-H
AZ SERVO LIMIT CW
J7-A
+26V DC
A3P4-4
EL SERVO LIMIT ±15V DC
J2-P
EL SERVO LIMIT UP
J7-E
26V DC RTN
K8
K9
K10
K11
CR8
CR9
CR10
CR11
AZ SERVO LIMIT STATUS
J5-V
-15V DC REG
A7P1-5
+15V DC REG
A7P1-7
EL SERVO LIMIT STATUS
J5-X
AZ SERVO LIMIT STATUS
J5-V
EL SERVO LIMIT STATUS
J5-X
B1
A2
X1
A3
B3
X2
B2
A1
RELAY BOTTOM VIEW
EL5895-915-34-TM-101

NOTES:

1. POWER TERMINATIONS ARE ALL REFERENCED TO POWER INPUT CONNECTOR J7, NOT WITHSTANDING TERMINAL BOARDS AND OTHER TIE POINTS.
2. RELAYS A4K6 AND A7K7 THRU A7K11 NOT USED.
3. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.

Figure FO-12. Relay circuit card assembly 14A7A4 through 14A7A7, schematic diagram (sheet 1 of 4)


P/O RELAY CIRCUIT CARD ASSEMBLY A5
A2P3-16 AZ SLEW VELOCITY
A2P3-14 AZ ERROR
A1P4-27 AZ SLEW COMMAND RELAY
A3P3-16 EL SLEW VELOCITY
A3P3-14 EL ERROR
A1P4-25 EL SLEW COMMAND RELAY
A1P3-11 SLAVE SOURCE AVAILABLE
J10-U SLAVE SOURCE AVAILABLE
A1P3-13 SIGNAL ACQUIRED
J8-L SIGNAL ACQUIRED
A1P3-15 SIGNAL DETECTED
J8-H SIGNAL DETECTED
J7-E 26V DC RTN
J9-N ANTENNA MAJOR FAULT (C)
J7-A +26V DC
A1P4-1 FAULT STATUS
K1
K2
K3
K4
K5
K6
CR1
CR2
CR3
CR4
CR5
CR6
AZ SLEW VELOCITY J5-B
AZ ERROR A4P2-14
EL SLEW VELOCITY J5-E
EL ERROR A4P3-6
SIGNAL GROUND
SLAVE SOURCE AVAILABLE A1P3-12
SIGNAL ACQUIRED A1P3-14
SIGNAL DETECTED A1P3-16
ANTENNA MAJOR FAULT (NC) J9-P
P/O RELAY CIRCUIT CARD ASSEMBLY A5
A1P4-5 SCR OPERATE COMMAND RELAY
A6P4-15 FAULT STATUS INTERLOCK
S1-(NC) ANTENNA SAFE INTERLOCK
A6P1-21 FAULT STATUS INTERLOCK
J2-B STOW STATUS
A6P1-5 FAULT STATUS INTERLOCK
J2-V AZ ELECTRICAL LIMIT
A6P1-13 FAULT STATUS INTERLOCK
J7-A +26V DC
J2-Y EL ELECTRICAL LIMIT
J7-E 26V DC RTN
K7
K8
K9
K10
K11
CR7
CR8
CR9
CR11
EL SCR OPERATE COMMAND J3-D
AZ SCR OPERATE COMMAND J3-X
FAULT STATUS INTERLOCK A6P3-12
ANTENNA SAFE DS6-A
FAULT STATUS INTERLOCK A6P3-22
ANTENNA STOWED DS3-A
FAULT STATUS INTERLOCK A6P2-20
AZ ELECTRICAL LIMIT DS9-A
FAULT STATUS INTERLOCK A6P3-2
EL ELECTRICAL LIMIT DS8-A

EL5895-915-34-TM-59 ②

Figure FO-12. Relay circuit card assembly 14A7A4 through 14A7A7, schematic diagram (sheet 2 of 4).

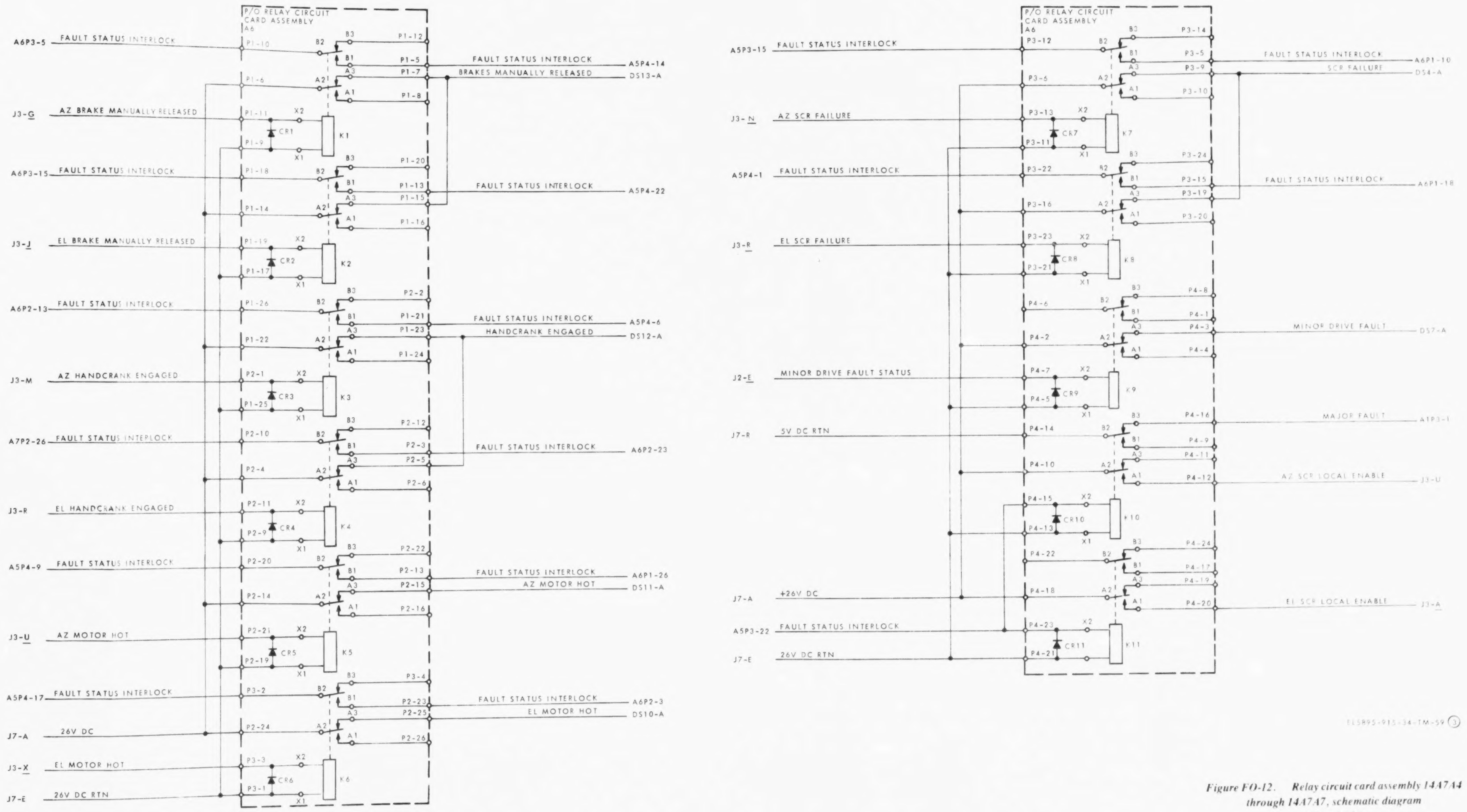

P/O RELAY CIRCUIT CARD ASSEMBLY A6
A6P3-5 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A5P4-14
BRAKES MANUALLY RELEASED DS13-A
J3-G AZ BRAKE MANUALLY RELEASED
K1
CR1
A6P3-15 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A5P4-22
J3-J EL BRAKE MANUALLY RELEASED
K2
CR2
A6P2-13 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A5P4-6
HANDCRANK ENGAGED DS12-A
J3-M AZ HANDCRANK ENGAGED
K3
CR3
A7P2-26 FAULT STATUS INTEPLOCK
FAULT STATUS INTERLOCK A6P2-23
J3-R EL HANDCRANK ENGAGED
K4
CR4
A5P4-9 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A6P1-26
AZ MOTOR HOT DS11-A
J3-U AZ MOTOR HOT
K5
CR5
A5P4-17 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A6P2-3
EL MOTOR HOT DS10-A
J7-A 26V DC
J3-X EL MOTOR HOT
K6
CR6
J7-E 26V DC RTN
P/O RELAY CIRCUIT CARD ASSEMBLY A6
A5P3-15 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A6P1-10
SCR FAILURE DS4-A
J3-N AZ SCR FAILURE
K7
CR7
A5P4-1 FAULT STATUS INTERLOCK
FAULT STATUS INTERLOCK A6P1-18
J3-R EL SCR FAILURE
K8
CR8
MINOR DRIVE FAULT DS7-A
J2-E MINOR DRIVE FAULT STATUS
K9
CR9
MAJOR FAULT A1P3-1
J7-R 5V DC RTN
AZ SCR LOCAL ENABLE J3-U
K10
CR10
J7-A +26V DC
EL SCR LOCAL ENABLE J3-A
A5P3-22 FAULT STATUS INTERLOCK
K11
CR11
J7-E 26V DC RTN
EL5895-915-34-TM-59 ③

Figure FO-12. Relay circuit card assembly 14A7A4 through 14A7A7, schematic diagram (sheet 3 of 4).
]

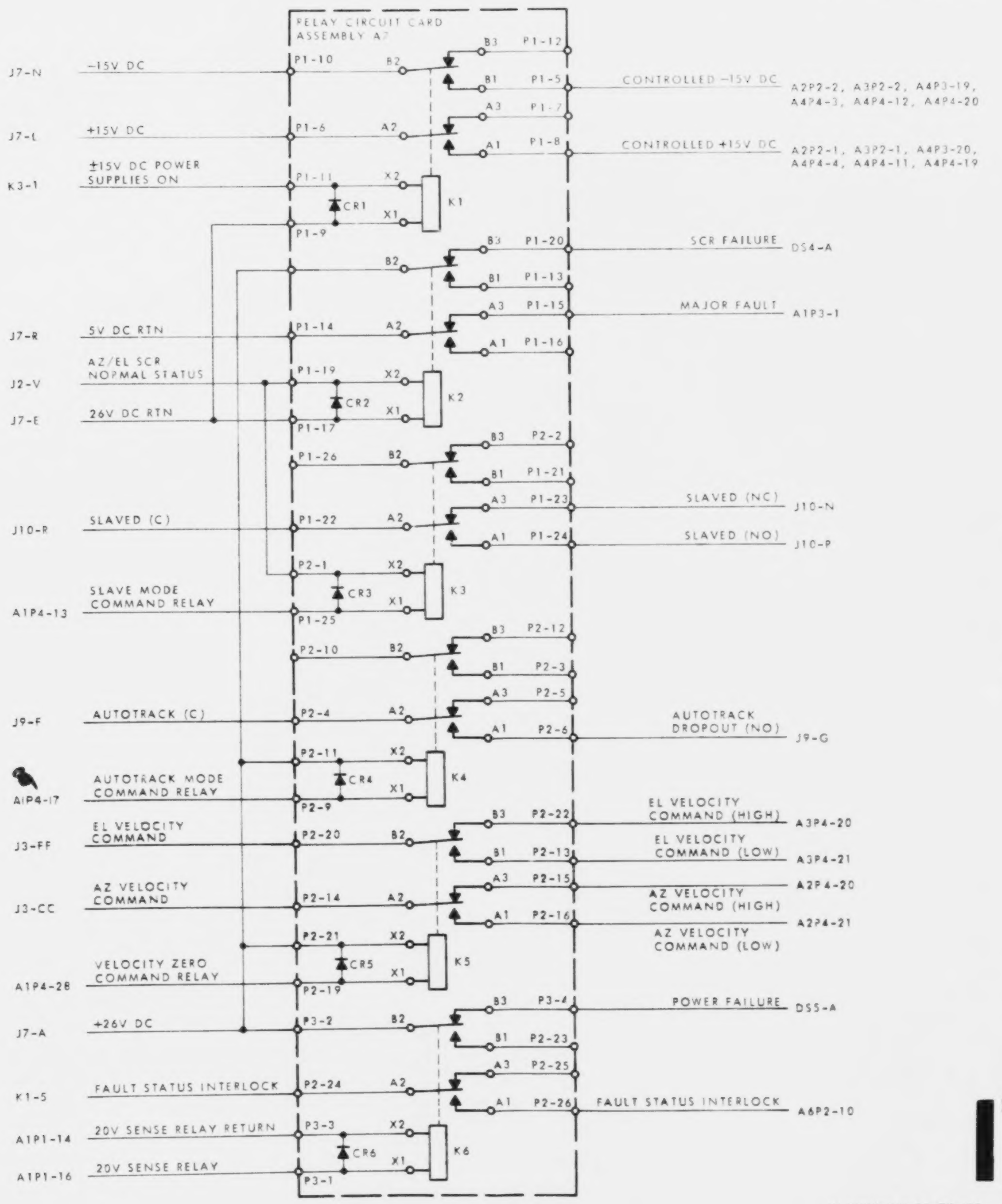
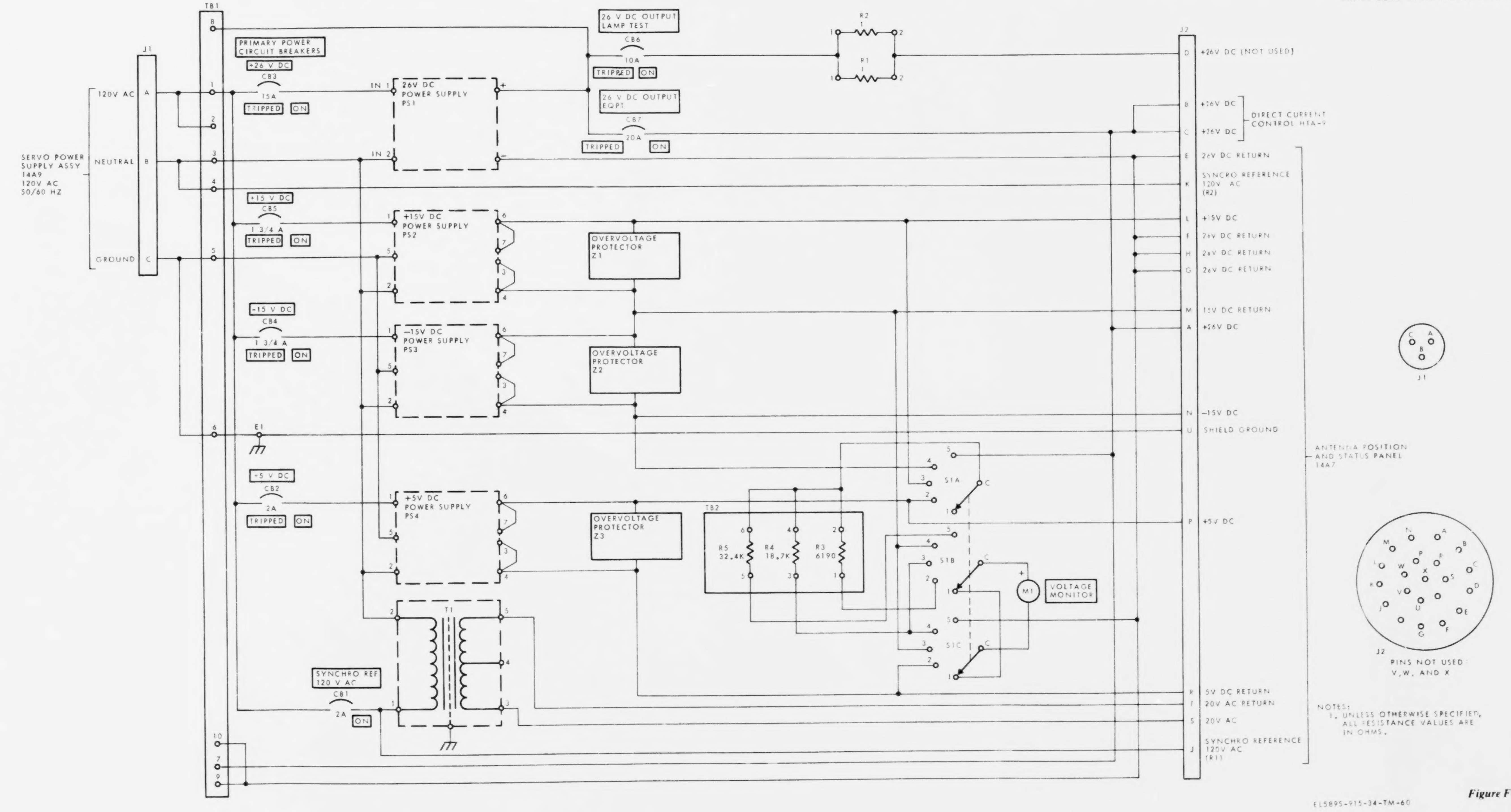

RELAY CIRCUIT CARD ASSEMBLY A7
J7-N −15V DC P1-10 B2
B3 P1-12
B1 P1-5 CONTROLLED −15V DC A2P2-2, A3P2-2, A4P3-19, A4P4-3, A4P4-12, A4P4-20
A3 P1-7
J7-L +15V DC P1-6 A2
A1 P1-8 CONTROLLED +15V DC A2P2-1, A3P2-1, A4P3-20, A4P4-4, A4P4-11, A4P4-19
K3-1 ±15V DC POWER SUPPLIES ON P1-11 X2
CR1
X1 P1-9
K1
B3 P1-20 SCR FAILURE DS4-A
B2
B1 P1-13
A3 P1-15 MAJOR FAULT A1P3-1
J7-R 5V DC RTN P1-14 A2
A1 P1-16
J2-V AZ/EL SCR NOPMAL STATUS P1-19 X2
CR2
J7-E 26V DC RTN P1-17 X1
K2
B3 P2-2
P1-26 B2
B1 P1-21
A3 P1-23 SLAVED (NC) J10-N
J10-R SLAVED (C) P1-22 A2
A1 P1-24 SLAVED (NO) J10-P
P2-1 X2
CR3
A1P4-13 SLAVE MODE COMMAND RELAY P1-25 X1
K3
B3 P2-12
P2-10 B2
B1 P2-3
A3 P2-5
J9-F AUTOTRACK (C) P2-4 A2
A1 P2-6 AUTOTRACK DROPOUT (NO) J9-G
P2-11 X2
CR4
A1P4-17 AUTOTRACK MODE COMMAND RELAY P2-9 X1
K4
B3 P2-22 EL VELOCITY COMMAND (HIGH) A3P4-20
J3-FF EL VELOCITY COMMAND P2-20 B2
B1 P2-13 EL VELOCITY COMMAND (LOW) A3P4-21
A3 P2-15 A2P4-20 AZ VELOCITY COMMAND (HIGH)
J3-CC AZ VELOCITY COMMAND P2-14 A2
A1 P2-16 A2P4-21 AZ VELOCITY COMMAND (LOW)
P2-21 X2
CR5
A1P4-28 VELOCITY ZERO COMMAND RELAY P2-19 X1
K5
B3 P3-4 POWER FAILURE DS5-A
J7-A +26V DC P3-2 B2
B1 P2-23
A3 P2-25
K1-5 FAULT STATUS INTERLOCK P2-24 A2
A1 P2-26 FAULT STATUS INTERLOCK A6P2-10
A1P1-14 20V SENSE RELAY RETURN P3-3 X2
CR6
A1P1-16 20V SENSE RELAY P3-1 X1
K6

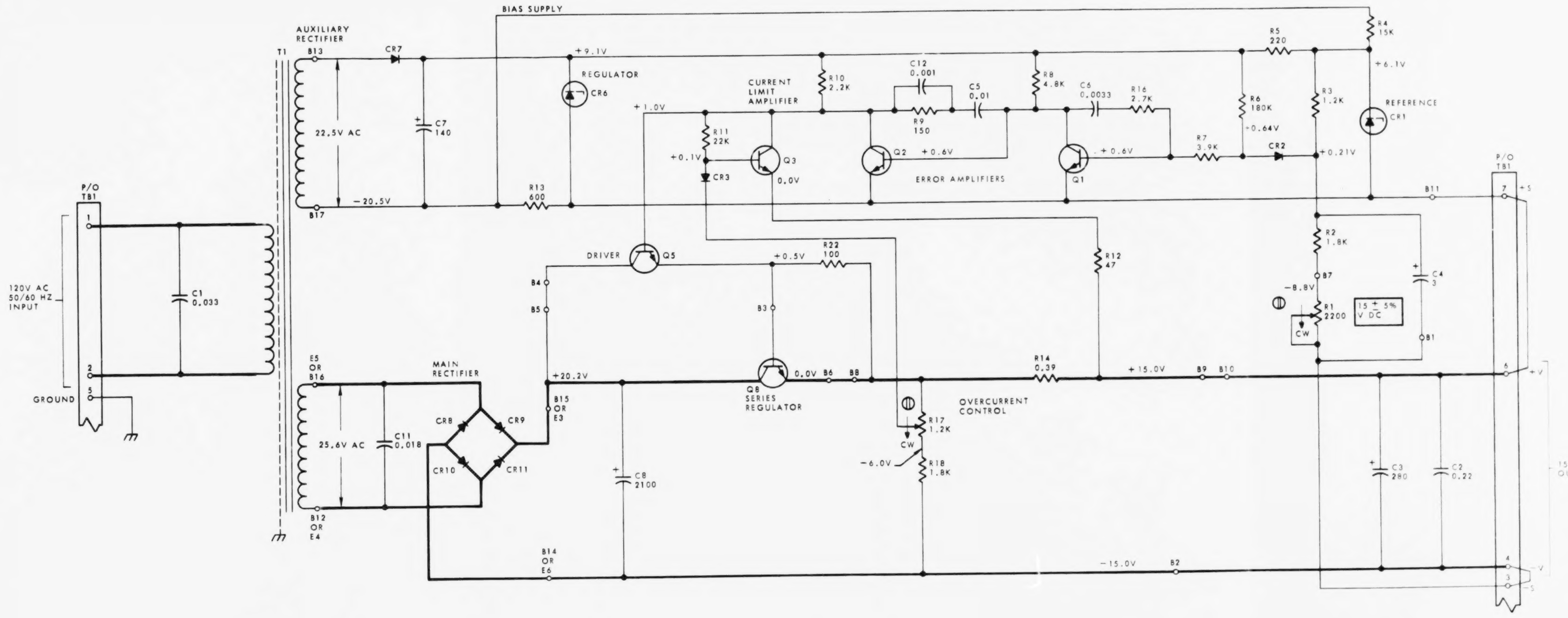
Figure FO-12. Relay circuit card assembly 14A7A4 through 14A7A7, schematic diagram (sheet 4 of 4).

EL5895-915-34-TM-102


TB1
J1
SERVO POWER SUPPLY ASSY 14A9 120V AC 50/60 HZ
120V AC
NEUTRAL
GROUND
PRIMARY POWER CIRCUIT BREAKERS
+26 V DC
CB3
15A
TRIPPED
ON
26V DC POWER SUPPLY PS1
IN 1
IN 2
26 V DC OUTPUT LAMP TEST
CB6
10A
26 V DC OUTPUT EQPT
CB7
20A
R2
R1
+15 V DC
CB5
1 3/4 A
+15V DC POWER SUPPLY PS2
OVERVOLTAGE PROTECTOR Z1
-15 V DC
CB4
1 3/4 A
−15V DC POWER SUPPLY PS3
OVERVOLTAGE PROTECTOR Z2
E1
+5 V DC
CB2
2A
+5V DC POWER SUPPLY PS4
OVERVOLTAGE PROTECTOR Z3
TB2
R5 32.4K
R4 18.7K
R3 6190
S1A
S1B
S1C
M1
VOLTAGE MONITOR
T1
SYNCHRO REF 120 V AC
CB1
2A
J2
+26V DC (NOT USED)
+26V DC
DIRECT CURRENT CONTROL HTA-9
+26V DC
26V DC RETURN
SYNCRO REFERENCE 120V AC (R2)
+15V DC
26V DC RETURN
26V DC RETURN
26V DC RETURN
15V DC RETURN
+26V DC
−15V DC
SHIELD GROUND
ANTENNA POSITION AND STATUS PANEL 14A7
+5V DC
5V DC RETURN
20V AC RETURN
20V AC
SYNCHRO REFERENCE 120V AC (R1)
J1
J2
PINS NOT USED V, W, AND X
NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS.

EL5895-915-34-TM-60

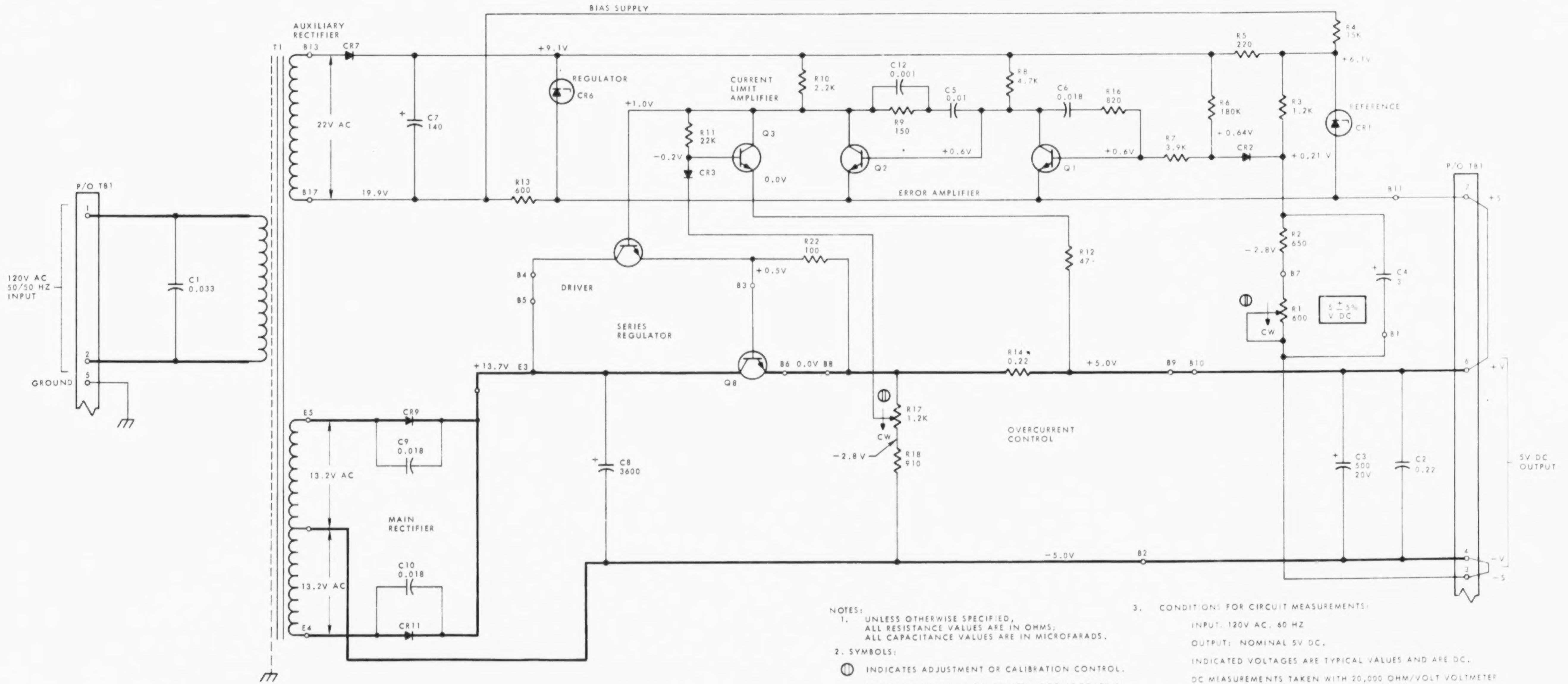
Figure FO-13. Servo power supply assembly 14A9, schematic diagram.


BIAS SUPPLY
AUXILIARY RECTIFIER
T1
B13
CR7
+9.1V
REGULATOR
CR6
22.5V AC
C7 140
−20.5V
B17
R13 600
P/O TB1
1
2
5
120V AC 50/60 HZ INPUT
GROUND
C1 0.033
E5 OR B16
MAIN RECTIFIER
25.6V AC
C11 0.018
CR8
CR9
CR10
CR11
B12 OR E4
B14 OR E6
B15 OR E3
+20.2V
C8 2100
B4
B5
DRIVER
Q5
CURRENT LIMIT AMPLIFIER
+1.0V
R11 22K
+0.1V
CR3
Q3
0.0V
R10 2.2K
C12 0.001
R9 150
C5 0.01
Q2
+0.6V
ERROR AMPLIFIERS
R8 4.8K
C6 0.0033
R16 2.7K
Q1
+0.6V
R7 3.9K
R6 180K
+0.64V
CR2
R5 220
R3 1.2K
+0.21V
R4 15K
+6.1V
REFERENCE
CR1
+0.5V
R22 100
B3
Q8 SERIES REGULATOR
0.0V
B6
B8
R12 47
OVERCURRENT CONTROL
R17 1.2K
CW
−6.0V
R18 1.8K
R14 0.39
+15.0V
B9
B10
−15.0V
B2
R2 1.8K
B7
−8.8V
R1 2200
CW
15 ± 5% V DC
C4 3
B1
B11
C3 280
C2 0.22
P/O TB1
7
+S
6
+V
4
−V
3
−S
15V DC OUTPUT

NOTES:
1. UNLESS OTHERWISE SPECIFIED,
ALL RESISTANCE VALUES ARE IN OHMS;
ALL CAPACITANCE VALUES ARE IN MICROFARADS.
2. SYMBOLS:
⦸ INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
-o- INDICATES TERMINAL ON PRINTED CIRCUIT BOARD B OR TERMINAL BOARD E.
3. CONDITIONS FOR CIRCUIT MEASUREMENTS:
INPUT: 120V AC, 60 HZ.
OUTPUT: NOMINAL 15V DC.
INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC.
DC MEASUREMENTS TAKEN WITH 20,000 OHM/VOLT VOLTMETER BETWEEN +S(TERM 7) AND INDICATED POINTS.
+S AND +V SHORTED, −S AND −V SHORTED.

EL 5895-915-34-TM-61

Figure FO-14. 15 V dc power supply 14A9PS2, A9PS3, schematic diagram.


BIAS SUPPLY
AUXILIARY RECTIFIER
T1
B13
CR7
22V AC
B17
19.9V
C7 140
+9.1V
REGULATOR
CR6
R13 600
+1.0V
R11 22K
-0.2V
CR3
Q3
0.0V
CURRENT LIMIT AMPLIFIER
R10 2.2K
C12 0.001
R9 150
C5 0.01
Q2
+0.6V
R8 4.7K
C6 0.018
R16 820
Q1
+0.6V
R7 3.9K
R6 180K
+0.64V
CR2
R5 220
R3 1.2K
+0.21 V
R4 15K
+6.1V
REFERENCE
CR1
ERROR AMPLIFIER
B11
P/O TB1
7
+S
R2 650
-2.8V
B7
C4 3
R1 600
CW
5 ± 5% V DC
B1
P/O TB1
1
2
5
120V AC 50/50 HZ INPUT
GROUND
C1 0.033
R22 100
+0.5V
B4
B5
B3
DRIVER
SERIES REGULATOR
+13.7V
E3
Q8
B6
0.0V
B8
R12 47
R14 0.22
+5.0V
B9
B10
6
+V
R17 1.2K
CW
-2.8V
R18 910
OVERCURRENT CONTROL
E5
CR9
C9 0.018
13.2V AC
MAIN RECTIFIER
C8 3600
C10 0.018
13.2V AC
CR11
E4
C3 500 20V
C2 0.22
5V DC OUTPUT
-5.0V
B2
4
3
-V
-S

NOTES:

1. UNLESS OTHERWISE SPECIFIED,
ALL RESISTANCE VALUES ARE IN OHMS;
ALL CAPACITANCE VALUES ARE IN MICROFARADS.

2. SYMBOLS:

Ⓘ INDICATES ADJUSTMENT OR CALIBRATION CONTROL.

—o— INDICATES TERMINAL ON PRINTED CIRCUIT BOARD B OR TERMINAL BOARD E.

3. CONDITIONS FOR CIRCUIT MEASUREMENTS:

INPUT: 120V AC, 60 HZ

OUTPUT: NOMINAL 5V DC.

INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC.

DC MEASUREMENTS TAKEN WITH 20,000 OHM/VOLT VOLTMETER BETWEEN S (TERM) AND INDICATED POINTS.

+S AND +V SHORTED, -S AND -V SHORTED.

EL5895-915-34-TM-62

Figure FO-15. ***5 V dc power supply 14A9PS4, schematic diagram.***

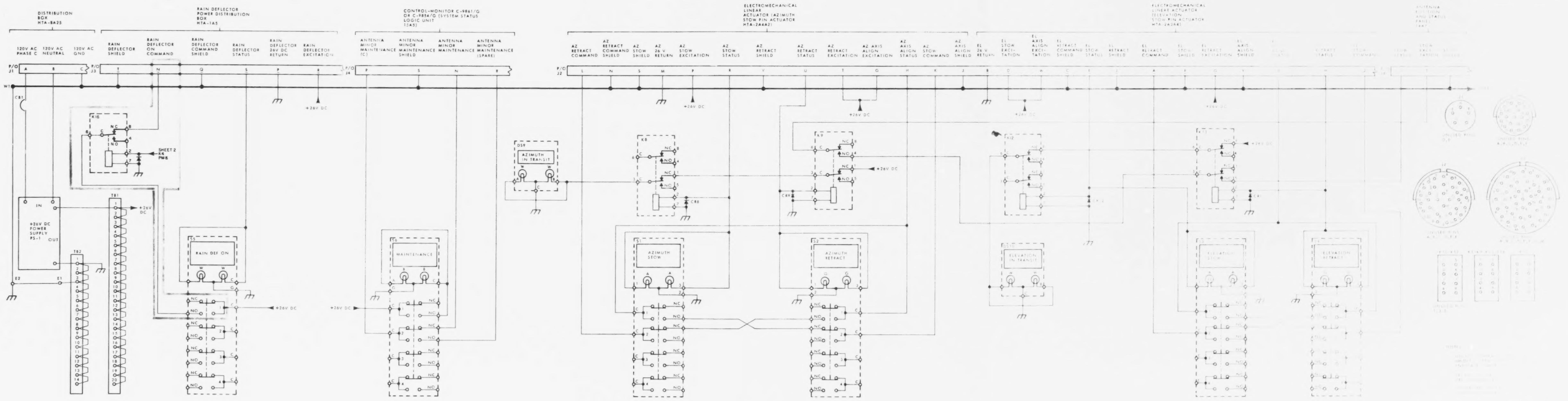

DISTRIBUTION BOX HTA-8A25
120V AC PHASE C
120V AC NEUTRAL
120V AC GND
RAIN DEFLECTOR POWER DISTRIBUTION BOX HTA-1A5
RAIN DEFLECTOR SHIELD
RAIN DEFLECTOR ON COMMAND
RAIN DEFLECTOR COMMAND SHIELD
RAIN DEFLECTOR STATUS
RAIN DEFLECTOR 26V DC RETURN
RAIN DEFLECTOR EXCITATION
CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
ANTENNA MINOR MAINTENANCE (C)
ANTENNA MINOR MAINTENANCE SHIELD
ANTENNA MINOR MAINTENANCE
ANTENNA MINOR MAINTENANCE (SPARE)
ELECTROMECHANICAL LINEAR ACTUATOR (AZIMUTH STOW PIN ACTUATOR HTA-2A4A2)
AZ RETRACT COMMAND
AZ RETRACT COMMAND SHIELD
AZ STOW SHIELD
AZ 26 V RETURN
AZ STOW EXCITATION
AZ STOW STATUS
AZ RETRACT SHIELD
AZ RETRACT STATUS
AZ RETRACT EXCITATION
AZ AXIS ALIGN EXCITATION
AZ AXIS ALIGN STATUS
AZ STOW COMMAND
AZ AXIS ALIGN SHIELD
EL 26 V RETURN
EL STOW EXCI-TATION
ANTENNA POSITION AND STATUS PANEL 1A47
P/O J1
P/O J3
P/O J4
P/O J2
W1
CB1
K16
SHEET 2 K4 PM8
+26V DC
DS9
AZIMUTH IN TRANSIT
K8
K9
K12
+26V DC POWER SUPPLY PS-1
ON
OUT
TB1
TB2
E1
E2
RAIN DEF ON
MAINTENANCE
AZIMUTH STOW
AZIMUTH RETRACT
ELEVATION IN TRANSIT
NC
NO
C

Figure FO-16. Stow pin, antenna fault summary panel assembly, schematic diagram (Sheet 1 of 2)

Change

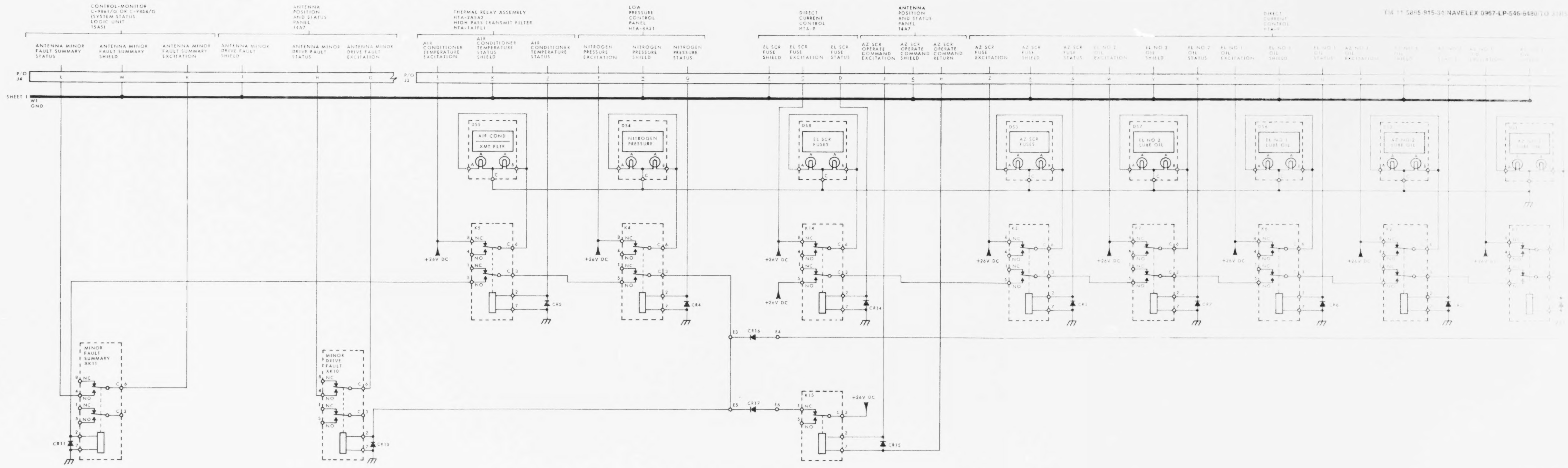

CONTROL-MONITOR
C-9861/G OR C-9854/G
(SYSTEM STATUS
LOGIC UNIT
15A5)
ANTENNA
POSITION
AND STATUS
PANEL
14A7
THERMAL RELAY ASSEMBLY
HTA-2A5A2
HIGH PASS TRANSMIT FILTER
HTA-1A1FL1
LOW
PRESSURE
CONTROL
PANEL
HTA-8A31
DIRECT
CURRENT
CONTROL
HTA-9
ANTENNA
POSITION
AND STATUS
PANEL
14A7
ANTENNA MINOR FAULT SUMMARY STATUS
ANTENNA MINOR FAULT SUMMARY SHIELD
ANTENNA MINOR FAULT SUMMARY EXCITATION
ANTENNA MINOR DRIVE FAULT SHIELD
ANTENNA MINOR DRIVE FAULT STATUS
ANTENNA MINOR DRIVE FAULT EXCITATION
AIR CONDITIONER TEMPERATURE EXCITATION
AIR CONDITIONER TEMPERATURE STATUS SHIELD
AIR CONDITIONER TEMPERATURE STATUS
NITROGEN PRESSURE EXCITATION
NITROGEN PRESSURE SHIELD
NITROGEN PRESSURE STATUS
EL SCR FUSE SHIELD
EL SCR FUSE EXCITATION
EL SCR FUSE STATUS
AZ SCR OPERATE COMMAND EXCITATION
AZ SCR OPERATE COMMAND SHIELD
AZ SCR OPERATE COMMAND RETURN
AZ SCR FUSE EXCITATION
AZ SCR FUSE SHIELD
AZ SCR FUSE STATUS
EL NO 2 OIL EXCITATION
EL NO 2 OIL SHIELD
EL NO 2 OIL STATUS
P/O J4
P/O J3
SHEET 1
W1 GND
DS5
AIR COND
XMT FLTR
DS4
NITROGEN PRESSURE
DS8
EL SCR FUSES
DS3
AZ SCR FUSES
DS7
EL NO 2 LUBE OIL
K14
K15
+26V DC
CR4
CR14
CR15
CR16
CR17
E3
E4
E5
E6
MINOR FAULT SUMMARY XK11
MINOR DRIVE FAULT XK10
CR11
CR10
NC
NO
C

Figure FO-16. Slew pin control minor fault summary panel HTA-8A28, schematic diagram (sheet 2 of 2).

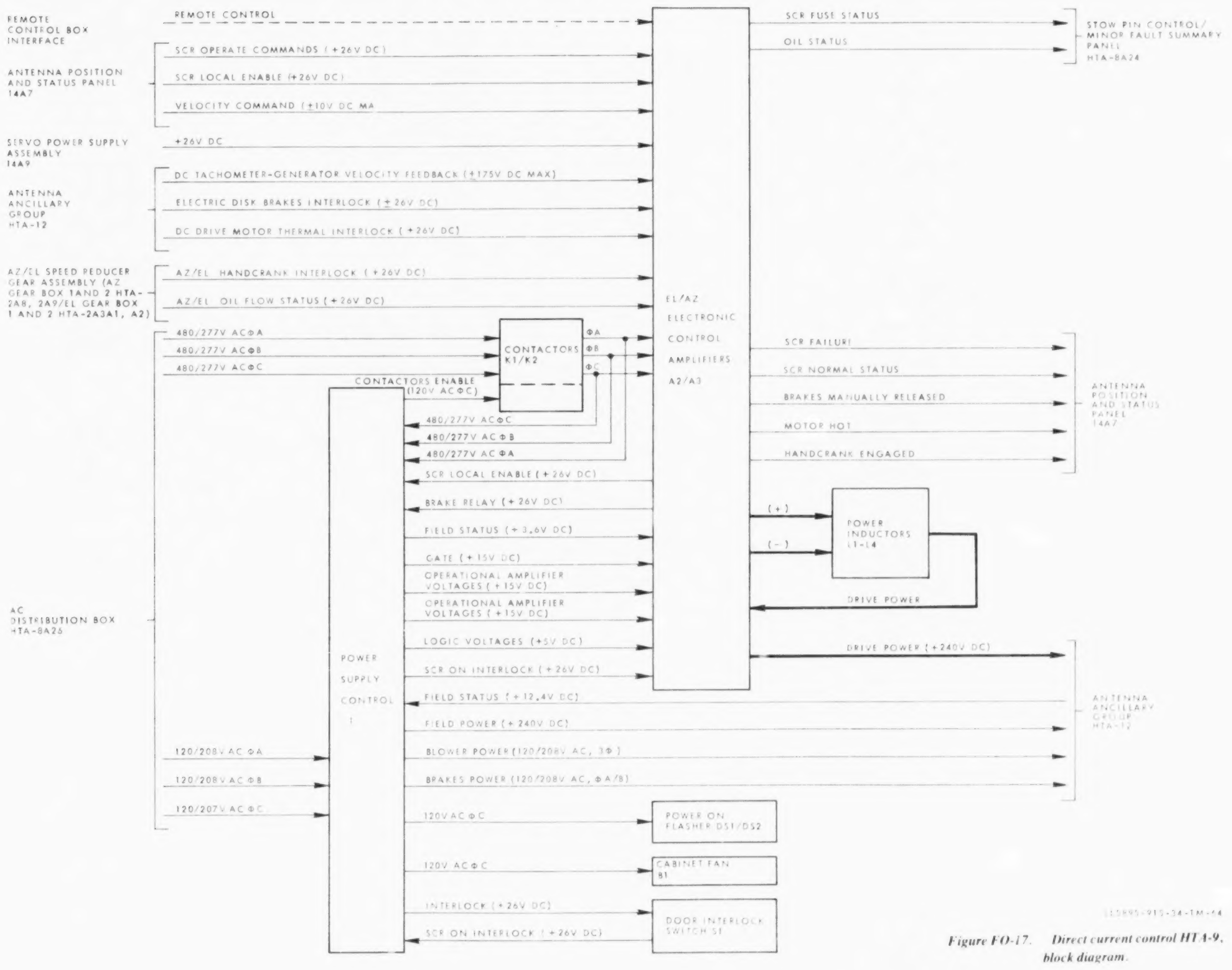

REMOTE CONTROL BOX INTERFACE
REMOTE CONTROL
ANTENNA POSITION AND STATUS PANEL 14A7
SCR OPERATE COMMANDS (+26V DC)
SCR LOCAL ENABLE (+26V DC)
VELOCITY COMMAND (±10V DC MA
SERVO POWER SUPPLY ASSEMBLY 14A9
+26V DC
ANTENNA ANCILLARY GROUP HTA-12
DC TACHOMETER-GENERATOR VELOCITY FEEDBACK (±175V DC MAX)
ELECTRIC DISK BRAKES INTERLOCK (±26V DC)
DC DRIVE MOTOR THERMAL INTERLOCK (+26V DC)
AZ/EL SPEED REDUCER GEAR ASSEMBLY (AZ GEAR BOX 1AND 2 HTA-2A8, 2A9/EL GEAR BOX 1 AND 2 HTA-2A3A1, A2)
AZ/EL HANDCRANK INTERLOCK (+26V DC)
AZ/EL OIL FLOW STATUS (+26V DC)
480/277V ACΦA
480/277V ACΦB
480/277V ACΦC
CONTACTORS K1/K2
ΦA
ΦB
ΦC
CONTACTORS ENABLE (120V ACΦC)
EL/AZ ELECTRONIC CONTROL AMPLIFIERS A2/A3
480/277V ACΦC
480/277V ACΦB
480/277V ACΦA
SCR LOCAL ENABLE (+26V DC)
BRAKE RELAY (+26V DC)
FIELD STATUS (+3.6V DC)
GATE (+15V DC)
OPERATIONAL AMPLIFIER VOLTAGES (+15V DC)
OPERATIONAL AMPLIFIER VOLTAGES (+15V DC)
LOGIC VOLTAGES (+5V DC)
SCR ON INTERLOCK (+26V DC)
FIELD STATUS (+12.4V DC)
FIELD POWER (+240V DC)
BLOWER POWER (120/208V AC, 3Φ)
BRAKES POWER (120/208V AC, ΦA/B)
AC DISTRIBUTION BOX HTA-8A26
POWER SUPPLY CONTROL 1
120/208V AC ΦA
120/208V AC ΦB
120/207V AC ΦC
120V AC ΦC
POWER ON FLASHER DS1/DS2
120V AC ΦC
CABINET FAN B1
INTERLOCK (+26V DC)
DOOR INTERLOCK SWITCH S1
SCR ON INTERLOCK (+26V DC)
SCR FUSE STATUS
OIL STATUS
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
SCR FAILURE
SCR NORMAL STATUS
BRAKES MANUALLY RELEASED
MOTOR HOT
HANDCRANK ENGAGED
ANTENNA POSITION AND STATUS PANEL 14A7
(+)
(−)
POWER INDUCTORS L1-L4
DRIVE POWER
DRIVE POWER (+240V DC)
ANTENNA ANCILLARY GROUP HTA-12
115895-915-34-TM-44

Figure FO-17. Direct current control HTA-9, block diagram.

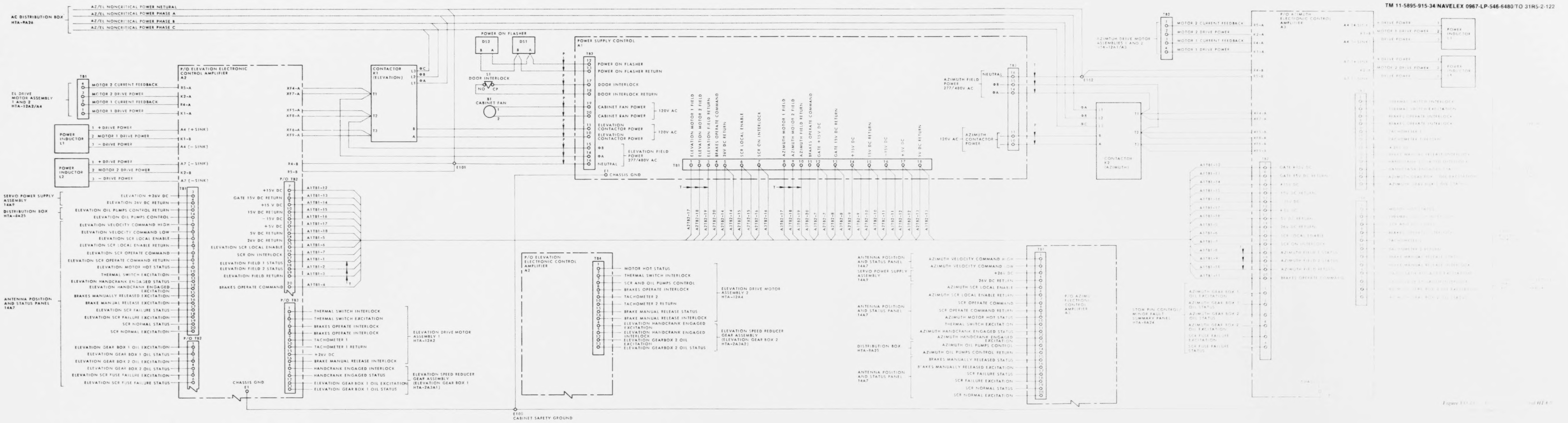

AC DISTRIBUTION BOX HTA-8A26
AZ/EL NONCRITICAL POWER NETURAL
AZ/EL NONCRITICAL POWER PHASE A
AZ/EL NONCRITICAL POWER PHASE B
AZ/EL NONCRITICAL POWER PHASE C
EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A2/A4
TB1
MOTOR 2 CURRENT FEEDBACK
MOTOR 2 DRIVE POWER
MOTOR 1 CURRENT FEEDBACK
MOTOR 1 DRIVE POWER
POWER INDUCTOR L1
POWER INDUCTOR L2
+ DRIVE POWER
MOTOR 1 DRIVE POWER
MOTOR 2 DRIVE POWER
− DRIVE POWER
P/O ELEVATION ELECTRONIC CONTROL AMPLIFIER A2
R5-A
K2-A
R4-A
K1-A
A4 (+SINK)
K1-B
A4 (−SINK)
A7 (−SINK)
K2-B
XF4-A
XF7-A
XF5-A
XF8-A
XF6-A
XF9-A
R4-B
R5-B
E101
CONTACTOR K1 (ELEVATION)
SERVO POWER SUPPLY ASSEMBLY 14A9
DISTRIBUTION BOX HTA-8A25
ANTENNA POSITION AND STATUS PANEL 14A7
ELEVATION +26V DC
ELEVATION 26V DC RETURN
ELEVATION OIL PUMPS CONTROL RETURN
ELEVATION OIL PUMPS CONTROL
ELEVATION VELOCITY COMMAND HIGH
ELEVATION VELOCITY COMMAND LOW
ELEVATION SCR LOCAL ENABLE
ELEVATION SCR LOCAL ENABLE RETURN
ELEVATION SCR OPERATE COMMAND
ELEVATION SCR OPERATE COMMAND RETURN
ELEVATION MOTOR HOT STATUS
THERMAL SWITCH EXCITATION
ELEVATION HANDCRANK ENGAGED STATUS
ELEVATION HANDCRANK ENGAGED EXCITATION
BRAKES MANUALLY RELEASED EXCITATION
BRAKE MANUAL RELEASE EXCITATION
ELEVATION SCR FAILURE STATUS
ELEVATION SCR FAILURE EXCITATION
SCR NORMAL STATUS
SCR NORMAL EXCITATION
P/O TB2
ELEVATION GEAR BOX 1 OIL EXCITATION
ELEVATION GEAR BOX 1 OIL STATUS
ELEVATION GEAR BOX 2 OIL EXCITATION
ELEVATION GEAR BOX 2 OIL STATUS
ELEVATION SCR FUSE FAILURE EXCITATION
ELEVATION SCR FUSE FAILURE STATUS
CHASSIS GND E1
+15V DC
GATE 15V DC RETURN
+15 V DC
15V DC RETURN
−15V DC
+5V DC
5V DC RETURN
26V DC RETURN
ELEVATION SCR LOCAL ENABLE
SCR ON INTERLOCK
ELEVATION FIELD 1 STATUS
ELEVATION FIELD 2 STATUS
ELEVATION FIELD RETURN
BRAKES OPERATE COMMAND
A1TB1-12
A1TB1-13
A1TB1-14
A1TB1-15
A1TB1-16
A1TB1-17
A1TB1-18
A1TB1-5
A1TB1-6
A1TB1-7
A1TB1-1
A1TB1-2
A1TB1-3
A1TB1-4
P/O TB3
THERMAL SWITCH INTERLOCK
THERMAL SWITCH EXCITATION
BRAKES OPERATE INTERLOCK
TACHOMETER 1
TACHOMETER 1 RETURN
+26V DC
BRAKE MANUAL RELEASE INTERLOCK
HANDCRANK ENGAGED INTERLOCK
HANDCRANK ENGAGED STATUS
ELEVATION DRIVE MOTOR ASSEMBLY 1 HTA-12A2
ELEVATION SPEED REDUCER GEAR ASSEMBLY (ELEVATION GEAR BOX 1 HTA-2A3A1)
POWER ON FLASHER
DS2
DS1
S1 DOOR INTERLOCK
NO
CP
B1 CABINET FAN
POWER SUPPLY CONTROL A1
TB2
POWER ON FLASHER
POWER ON FLASHER RETURN
DOOR INTERLOCK
DOOR INTERLOCK RETURN
CABINET FAN POWER
120V AC
ELEVATION CONTACTOR POWER
ELEVATION FIELD POWER 277/480V AC
NEUTRAL
E1 CHASSIS GND
TB1
ELEVATION MOTOR 1 FIELD
ELEVATION MOTOR 2 FIELD
ELEVATION FIELD RETURN
BRAKES OPERATE COMMAND
26V DC RETURN
SCR LOCAL ENABLE
SCR ON INTERLOCK
AZIMUTH MOTOR 1 FIELD
AZIMUTH MOTOR 2 FIELD
AZIMUTH FIELD RETURN
GATE +15V DC
GATE 15V DC RETURN
+15V DC
15V DC RETURN
−15V DC
+5V DC
5V DC RETURN
A2TB2-17
A2TB2-18
A2TB2-19
A2TB2-20
A2TB2-14
A3TB2-14
A2TB2-15
A3TB2-15
A2TB2-16
A3TB2-16
A3TB2-17
A3TB2-18
A3TB2-19
A3TB2-20
A3TB2-7
A2TB2-7
A2TB2-8
A3TB2-8
A2TB2-9
A3TB2-9
A2TB2-10
A3TB2-10
A2TB2-11
A3TB2-11
A2TB2-12
A3TB2-12
A2TB2-13
A3TB2-13
P/O ELEVATION ELECTRONIC CONTROL AMPLIFIER A2
TB4
MOTOR HOT STATUS
THERMAL SWITCH INTERLOCK
SCR AND OIL PUMPS CONTROL
BRAKES OPERATE INTERLOCK
TACHOMETER 2
TACHOMETER 2 RETURN
BRAKE MANUAL RELEASE STATUS
BRAKE MANUAL RELEASE INTERLOCK
ELEVATION HANDCRANK ENGAGED EXCITATION
ELEVATION HANDCRANK ENGAGED INTERLOCK
ELEVATION GEARBOX 2 OIL EXCITATION
ELEVATION GEARBOX 2 OIL STATUS
ELEVATION DRIVE MOTOR ASSEMBLY 2 HTA-12A4
ELEVATION SPEED REDUCER GEAR ASSEMBLY (ELEVATION GEAR BOX 2 HTA-2A3A2)
E100 CABINET SAFETY GROUND
AZIMUTH FIELD POWER 277/480V AC
AZIMUTH CONTACTOR POWER
TB3
E102
CONTACTOR K2 (AZIMUTH)
AZIMTUH DRIVE MOTOR ASSEMBLIES 1 AND 2 HTA-12A1/A3
P/O AZIMUTH ELECTRONIC CONTROL AMPLIFIER A3
POWER INDUCTOR L1
POWER INDUCTOR L2
AZIMUTH VELOCITY COMMAND HIGH
AZIMUTH VELOCITY COMMAND LOW
+26V DC
26V DC RETURN
AZIMUTH SCR LOCAL ENABLE
AZIMUTH SCR LOCAL ENABLE RETURN
SCR OPERATE COMMAND
SCR OPERATE COMMAND RETURN
AZIMUTH MOTOR HOT STATUS
THERMAL SWITCH EXCITATION
AZIMUTH HANDCRANK ENGAGED STATUS
AZIMUTH HANDCRANK ENGAGED EXCITATION
AZIMUTH OIL PUMPS CONTROL
AZIMUTH OIL PUMPS CONTROL RETURN
BRAKES MANUALLY RELEASED STATUS
BRAKES MANUALLY RELEASED EXCITATION
SCR FAILURE STATUS
SCR FAILURE EXCITATION
SCR NORMAL STATUS
SCR NORMAL EXCITATION
A1TB1-8
A1TB1-9
A1TB1-10
A1TB1-11
AZIMUTH FIELD 1 STATUS
AZIMUTH FIELD 2 STATUS
AZIMUTH FIELD RETURN
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
AZIMUTH GEAR BOX 1 OIL EXCITATION
AZIMUTH GEAR BOX 1 OIL STATUS
AZIMUTH GEAR BOX 2 OIL STATUS
AZIMUTH GEAR BOX 2 OIL EXCITATION
SCR FUSE FAILURE EXCITATION
SCR FUSE FAILURE STATUS

Figure [illegible] and HTA-[illegible]

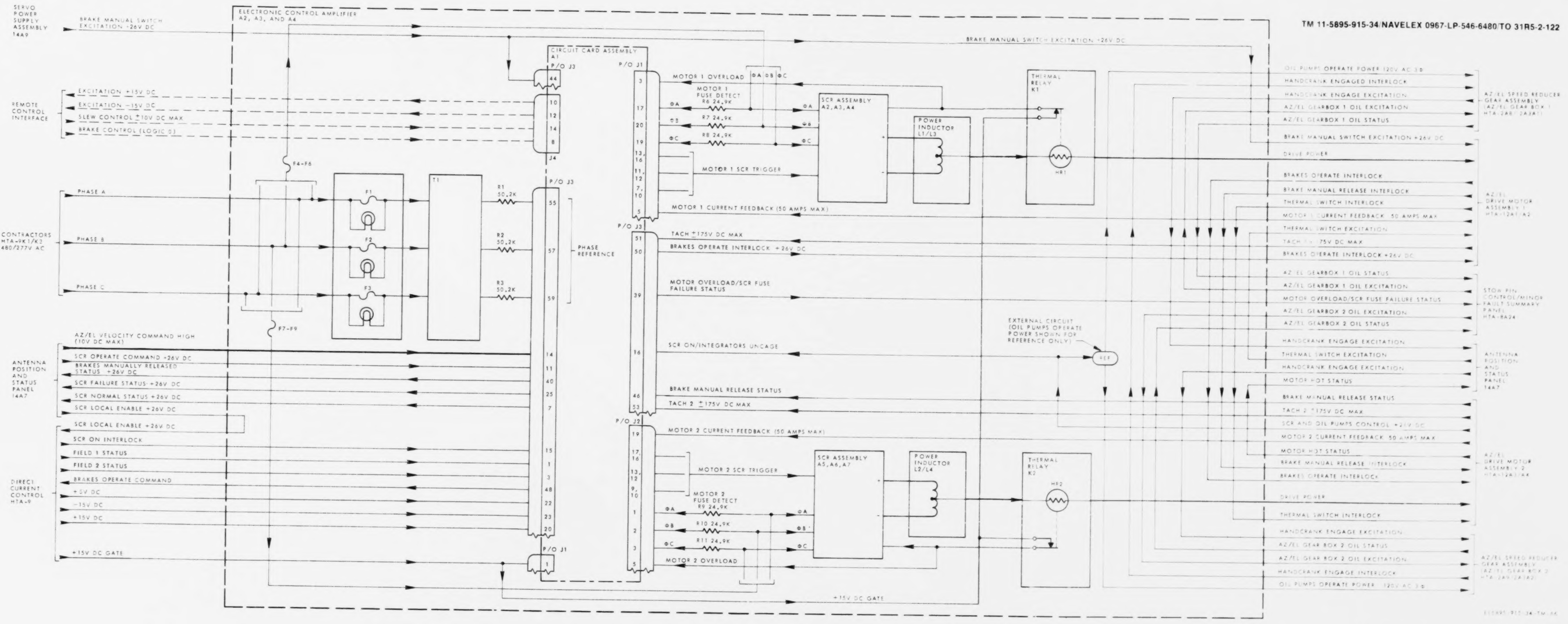
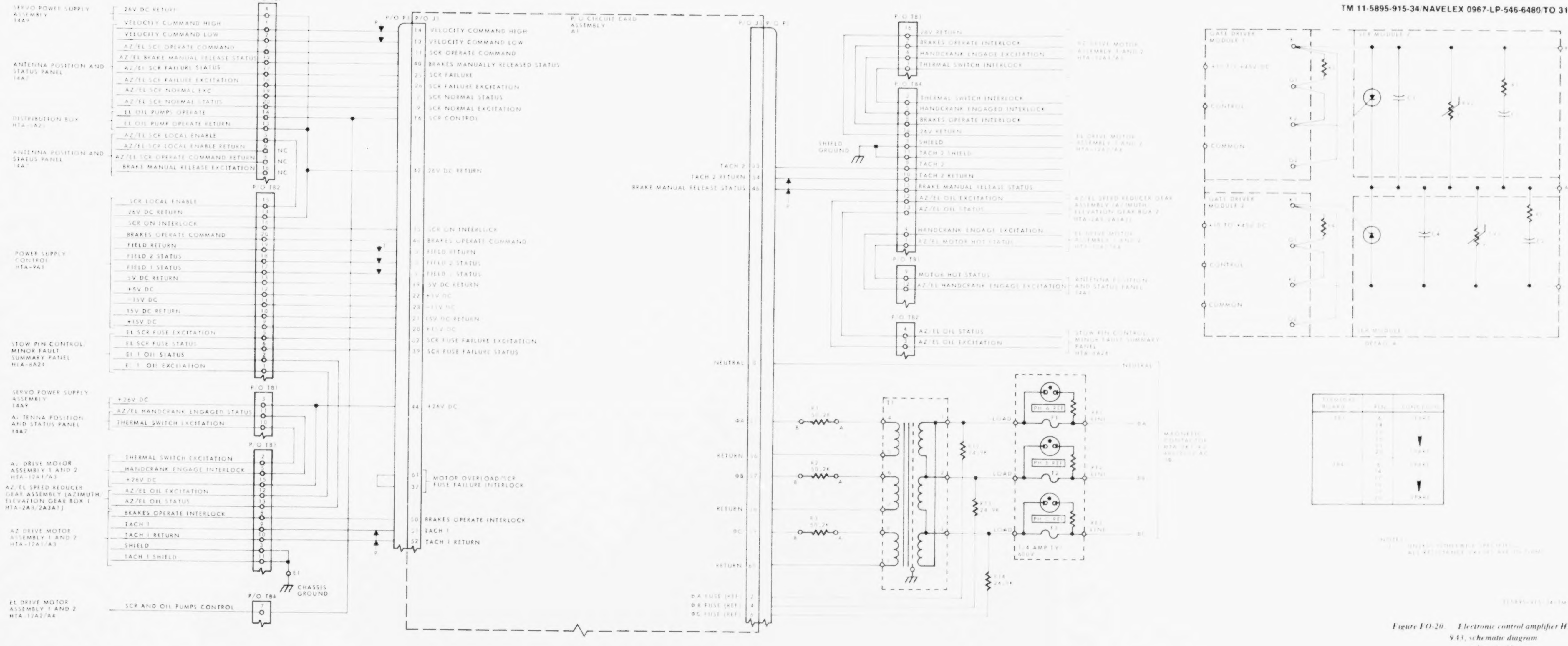

SERVO POWER SUPPLY ASSEMBLY 14A9
BRAKE MANUAL SWITCH EXCITATION +26V DC
ELECTRONIC CONTROL AMPLIFIER A2, A3, AND A4
REMOTE CONTROL INTERFACE
EXCITATION +15V DC
EXCITATION −15V DC
SLEW CONTROL ±10V DC MAX
BRAKE CONTROL (LOGIC 0)
F4-F6
F7-F9
CONTRACTORS HTA-9K1/K2 480/277V AC
PHASE A
PHASE B
PHASE C
F1
F2
F3
T1
R1 50.2K
R2 50.2K
R3 50.2K
PHASE REFERENCE
CIRCUIT CARD ASSEMBLY A1
P/O J3
P/O J1
P/O J2
J4
ANTENNA POSITION AND STATUS PANEL 14A7
AZ/EL VELOCITY COMMAND HIGH (10V DC MAX)
SCR OPERATE COMMAND +26V DC
BRAKES MANUALLY RELEASED STATUS +26V DC
SCR FAILURE STATUS +26V DC
SCR NORMAL STATUS +26V DC
SCR LOCAL ENABLE +26V DC
DIRECT CURRENT CONTROL HTA-9
SCR ON INTERLOCK
FIELD 1 STATUS
FIELD 2 STATUS
BRAKES OPERATE COMMAND
+5V DC
−15V DC
+15V DC
+15V DC GATE
MOTOR 1 OVERLOAD
MOTOR 1 FUSE DETECT
R6 24.9K
R7 24.9K
R8 24.9K
ΦA ΦB ΦC
SCR ASSEMBLY A2,A3,A4
POWER INDUCTOR L1/L3
THERMAL RELAY K1
HR1
MOTOR 1 SCR TRIGGER
MOTOR 1 CURRENT FEEDBACK (50 AMPS MAX)
TACH ±175V DC MAX
BRAKES OPERATE INTERLOCK +26V DC
MOTOR OVERLOAD/SCR FUSE FAILURE STATUS
SCR ON/INTEGRATORS UNCAGE
EXTERNAL CIRCUIT (OIL PUMPS OPERATE POWER SHOWN FOR REFERENCE ONLY)
REF
BRAKE MANUAL RELEASE STATUS
TACH 2 ±175V DC MAX
MOTOR 2 CURRENT FEEDBACK (50 AMPS MAX)
MOTOR 2 SCR TRIGGER
SCR ASSEMBLY A5,A6,A7
POWER INDUCTOR L2/L4
THERMAL RELAY K2
HR2
MOTOR 2 FUSE DETECT
R9 24.9K
R10 24.9K
R11 24.9K
MOTOR 2 OVERLOAD
OIL PUMPS OPERATE POWER 120V AC 3Φ
HANDCRANK ENGAGED INTERLOCK
HANDCRANK ENGAGE EXCITATION
AZ/EL GEARBOX 1 OIL EXCITATION
AZ/EL GEARBOX 1 OIL STATUS
AZ/EL SPEED REDUCER GEAR ASSEMBLY (AZ/EL GEAR BOX 1 HTA-2A8 (2A3A1))
BRAKE MANUAL SWITCH EXCITATION +26V DC
DRIVE POWER
BRAKES OPERATE INTERLOCK
BRAKE MANUAL RELEASE INTERLOCK
THERMAL SWITCH INTERLOCK
MOTOR 1 CURRENT FEEDBACK 50 AMPS MAX
THERMAL SWITCH EXCITATION
TACH 1 ±175V DC MAX
BRAKES OPERATE INTERLOCK +26V DC
AZ/EL DRIVE MOTOR ASSEMBLY 1 HTA-12A1/A2
AZ/EL GEARBOX 1 OIL STATUS
AZ/EL GEARBOX 1 OIL EXCITATION
MOTOR OVERLOAD/SCR FUSE FAILURE STATUS
AZ/EL GEARBOX 2 OIL EXCITATION
AZ/EL GEARBOX 2 OIL STATUS
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
HANDCRANK ENGAGE EXCITATION
THERMAL SWITCH EXCITATION
HANDCRANK ENGAGE EXCITATION
MOTOR HOT STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
BRAKE MANUAL RELEASE STATUS
TACH 2 ±175V DC MAX
SCR AND OIL PUMPS CONTROL +26V DC
MOTOR 2 CURRENT FEEDBACK 50 AMPS MAX
MOTOR HOT STATUS
BRAKE MANUAL RELEASE INTERLOCK
BRAKES OPERATE INTERLOCK
DRIVE POWER
THERMAL SWITCH INTERLOCK
AZ/EL DRIVE MOTOR ASSEMBLY 2 HTA-12A3/A4
HANDCRANK ENGAGE EXCITATION
AZ/EL GEAR BOX 2 OIL STATUS
AZ/EL GEAR BOX 2 OIL EXCITATION
HANDCRANK ENGAGE INTERLOCK
OIL PUMPS OPERATE POWER 120V AC 3Φ
AZ/EL SPEED REDUCER GEAR ASSEMBLY (AZ/EL GEAR BOX 2 HTA-2A9 (2A3A2))

Figure FO-19. Electronic control amplifier HTA-9A2, 9A3, functional schematic diagram


CHASSIS GROUND
SHIELD GROUND

NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS

Figure FO-20. Electronic control amplifier HT-1-942, 943, schematic diagram (sheet 1 of 2).

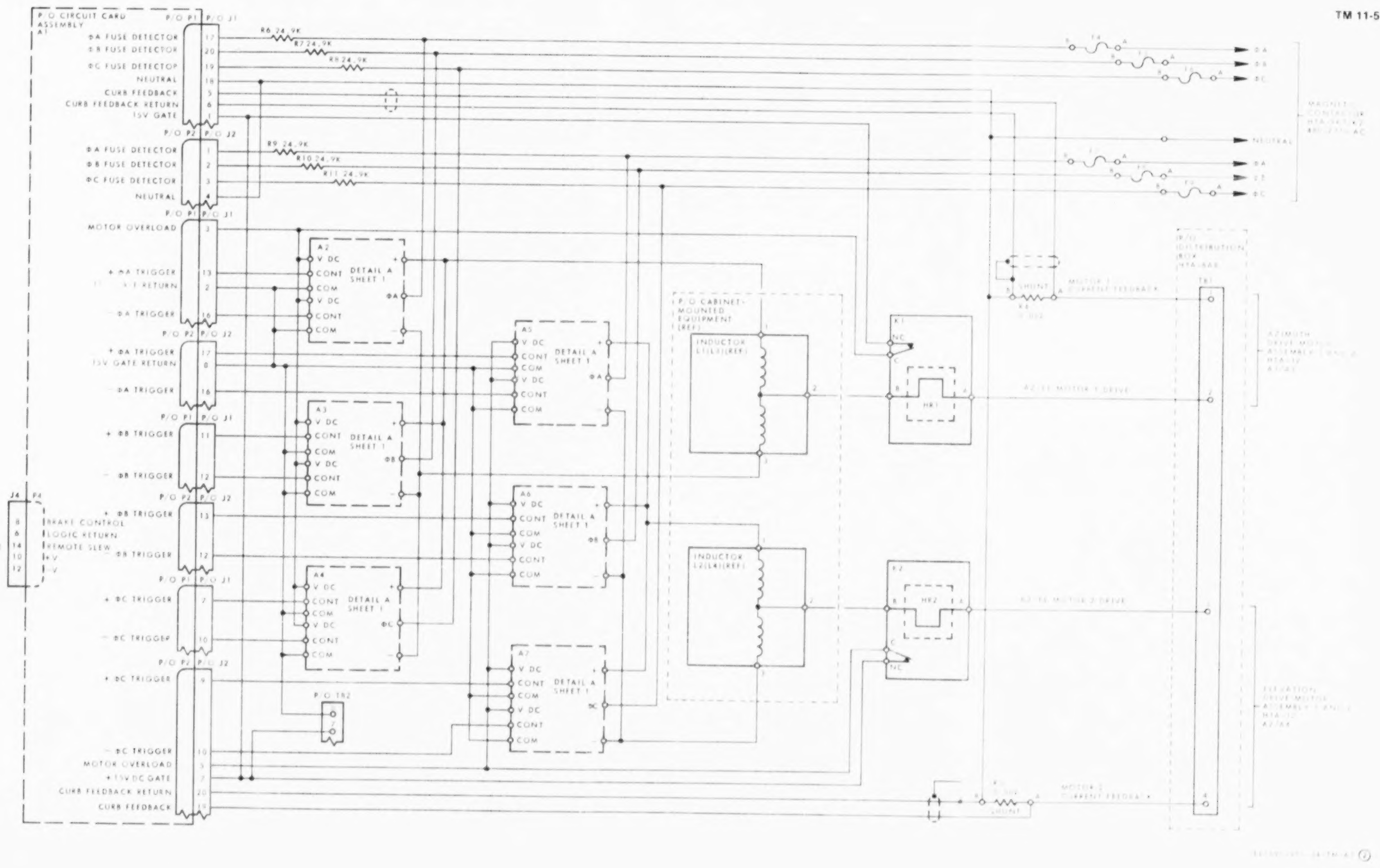

P/O CIRCUIT CARD ASSEMBLY A1
REMOTE CONTROL INTERFACE
DETAIL A SHEET 1
V DC
CONT
COM
INDUCTOR
NEUTRAL
MOTOR OVERLOAD
MAGNETIC CONTACTOR

Figure FO-20. Electronic control amplifier HTA-9A2, 9AS, schematic diagram (sheet 2 of 2)

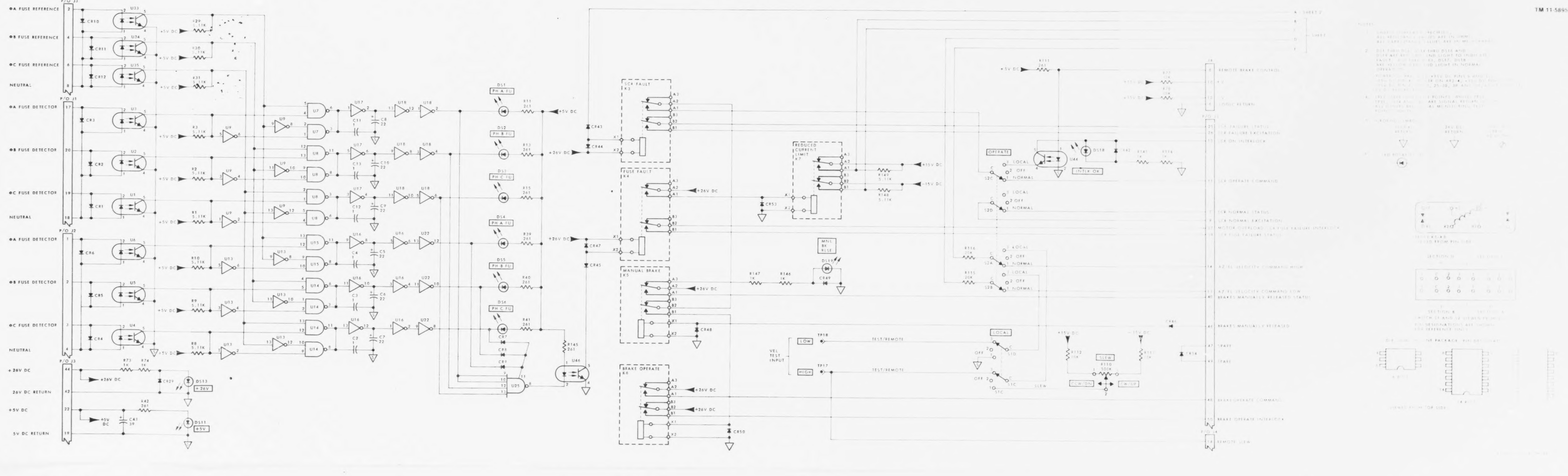
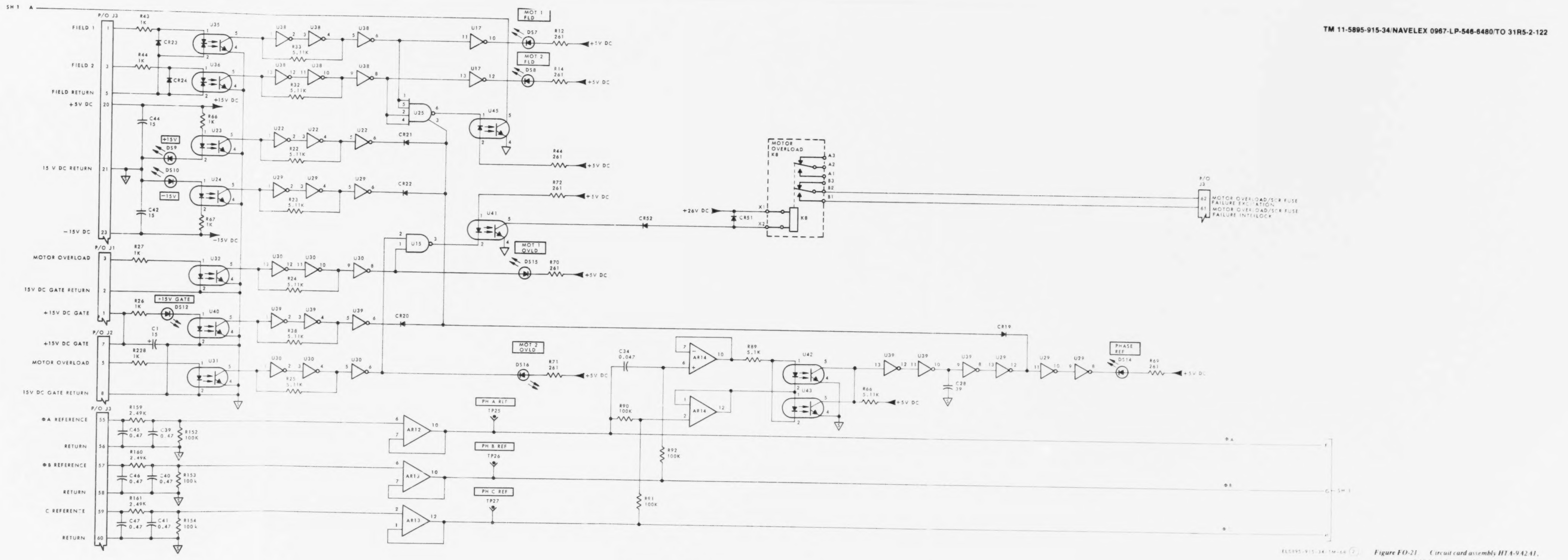

P/O J3
ΦA FUSE REFERENCE
ΦB FUSE REFERENCE
ΦC FUSE REFERENCE
NEUTRAL
P/O J1
ΦA FUSE DETECTOR
ΦB FUSE DETECTOR
ΦC FUSE DETECTOR
NEUTRAL
P/O J2
ΦA FUSE DETECTOR
ΦB FUSE DETECTOR
ΦC FUSE DETECTOR
NEUTRAL
P/O J3
+26V DC
26V DC RETURN
+5V DC
5V DC RETURN
U33
U34
U35
U3
U2
U1
U6
U5
U4
CR10
CR11
CR12
CR3
CR2
CR1
CR6
CR5
CR4
R29 5.11K
R30 5.11K
R31 5.11K
R3 5.11K
R2 5.11K
R1 5.11K
R10 5.11K
R9 5.11K
R8 5.11K
+5V DC
U9
U13
R73 1K
R74 1K
+26V DC
CR29
DS13
+26V
R42 261
C43 39
DS11
+5V
SCR FAULT K3
FUSE FAULT K4
MANUAL BRAKE K5
BRAKE OPERATE K6
REDUCED CURRENT LIMIT K7
CR43
CR44
CR47
CR45
CR48
CR50
CR53
CR49
U46
R145
R147 1K
R146 1K
MNL BK RLSE
DS19
R149 5.11K
R148 5.11K
+15V DC
−15V DC
OPERATE
LOCAL
OFF
NORMAL
S2A
S2B
S2C
S2D
S1C
S1D
R116 20K
R115 20K
R111 261
U44
DS18
INTLK OK
VEL TEST INPUT
LOW
HIGH
TP18
TP17
TEST/REMOTE
SLEW
R112 10K
R113 10K
R110 500K
CCW/DN
CW/UP
CR46
CR54
A SHEET 2
B
C
D
E
SHEET
J4
REMOTE BRAKE CONTROL
LOGIC RETURN
P/O J1
SCR FAILURE STATUS
SCR FAILURE EXCITATION
SCR ON INTERLOCK
SCR OPERATE COMMAND
SCR NORMAL STATUS
SCR NORMAL EXCITATION
MOTOR OVERLOAD (SCR FUSE FAILURE INTERLOCK
SCR FUSE FAILURE STATUS
AZ/EL VELOCITY COMMAND HIGH
AZ/EL VELOCITY COMMAND LOW
BRAKES MANUALLY RELEASED STATUS
BRAKES MANUALLY RELEASED
SPARE
SPARE
BRAKE OPERATE COMMAND
BRAKE OPERATE INTERLOCK
P/O J4
REMOTE SLEW
NOTES:
26V DC RETURN
SECTION B
SWITCH S1 AND S2 VIEWED FROM
DUAL IN-LINE PACKAGE PIN DESIGNATION
8 PIN
14 PIN
VIEWED FROM TOP SIDE

Figure FO-21. [illegible] A3A1, schematic diagram (sheet 1 of [illegible])


SH 1
A
P/O J3
FIELD 1
FIELD 2
FIELD RETURN
+5V DC
15 V DC RETURN
−15V DC
P/O J1
MOTOR OVERLOAD
15V DC GATE RETURN
+15V DC GATE
P/O J2
+15V DC GATE
MOTOR OVERLOAD
15V DC GATE RETURN
P/O J3
ΦA REFERENCE
RETURN
ΦB REFERENCE
RETURN
C REFERENCE
RETURN
R43 1K
R44 1K
CR23
CR24
U35
U36
+15V DC
C44 15
R66 1K
+15V
DS9
DS10
−15V
U23
U24
C42 15
R67 1K
−15V DC
R27 1K
U32
R26 1K
+15V GATE
DS12
U40
C1 15
R228 1K
U31
R159 2.49K
C45 0.47
C39 0.47
R152 100K
R160 2.49K
C46 0.47
C40 0.47
R153 100K
R161 2.49K
C47 0.47
C41 0.47
R154 100K
U38
U22
U29
U30
U39
R33 5.11K
R32 5.11K
R22 5.11K
R23 5.11K
R24 5.11K
R38 5.11K
R25 5.11K
MOT 1 FLD
MOT 2 FLD
MOT 1 OVLD
MOT 2 OVLD
+5V DC
+26V DC
CR51
MOTOR OVERLOAD K8
A3
A2
A1
B3
B2
B1
X1
X2
K8
P/O J3
62 MOTOR OVERLOAD/SCR FUSE FAILURE EXCITATION
61 MOTOR OVERLOAD/SCR FUSE FAILURE INTERLOCK
CR19
PHASE REF
PH A REF
PH B REF
PH C REF
AR12
AR13
AR14
R89
SH 1

TL5895-915-34-TM-66 (2)

Figure FO-21. Circuit card assembly HTA-9/A2A1, 9A3A1, schematic diagram (sheet 2 of 3).

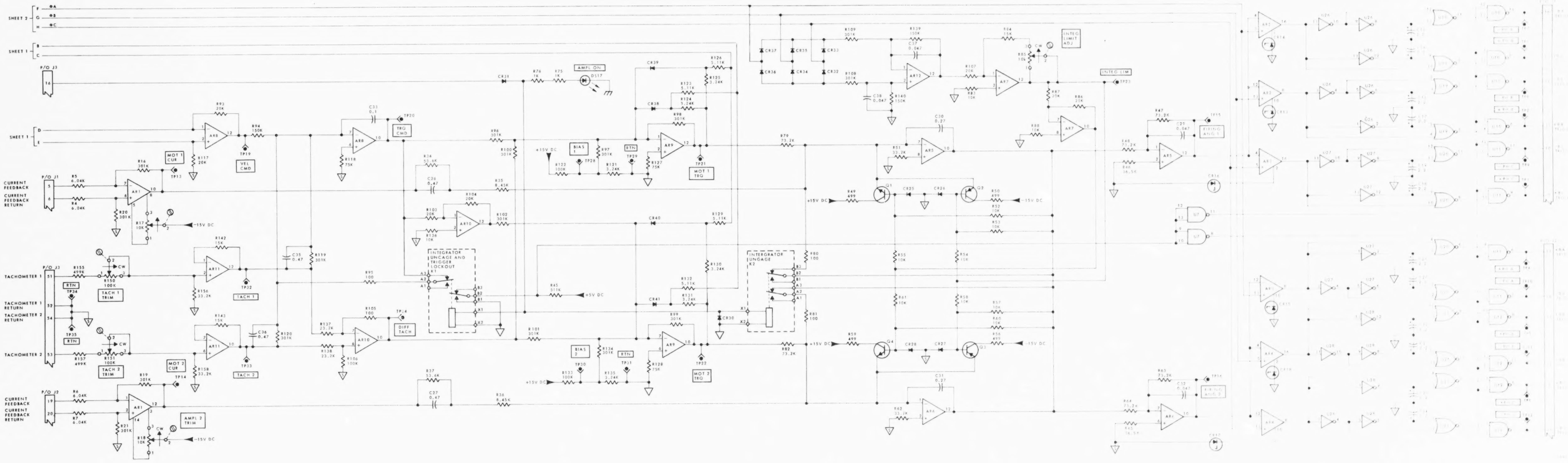

SHEET 2
SHEET 1
P/O J1
CURRENT FEEDBACK
CURRENT FEEDBACK RETURN
TACHOMETER 1
TACHOMETER 1 RETURN
TACHOMETER 2 RETURN
TACHOMETER 2
P/O J2
MOT 1 CUR
MOT 2 CUR
VEL CMD
TACH 1
TACH 2
TACH 1 TRIM
TACH 2 TRIM
AMPL 2 TRIM
TRQ CMD
DIFF TACH
BIAS
BIAS 2
ETG
MOT 1 TRQ
MOT 2 TRQ
AMPL ON
INTEGRATOR UNCAGE AND TRIGGER LOCKOUT
INTEGRATOR UNCAGE
INTEG LIMIT ADJ
INTEG LIM
+15V DC
-15V DC

Figure FO-21. Circuit card assembly [illegible] [illegible], schematic diagram (sheet 3 of 3)

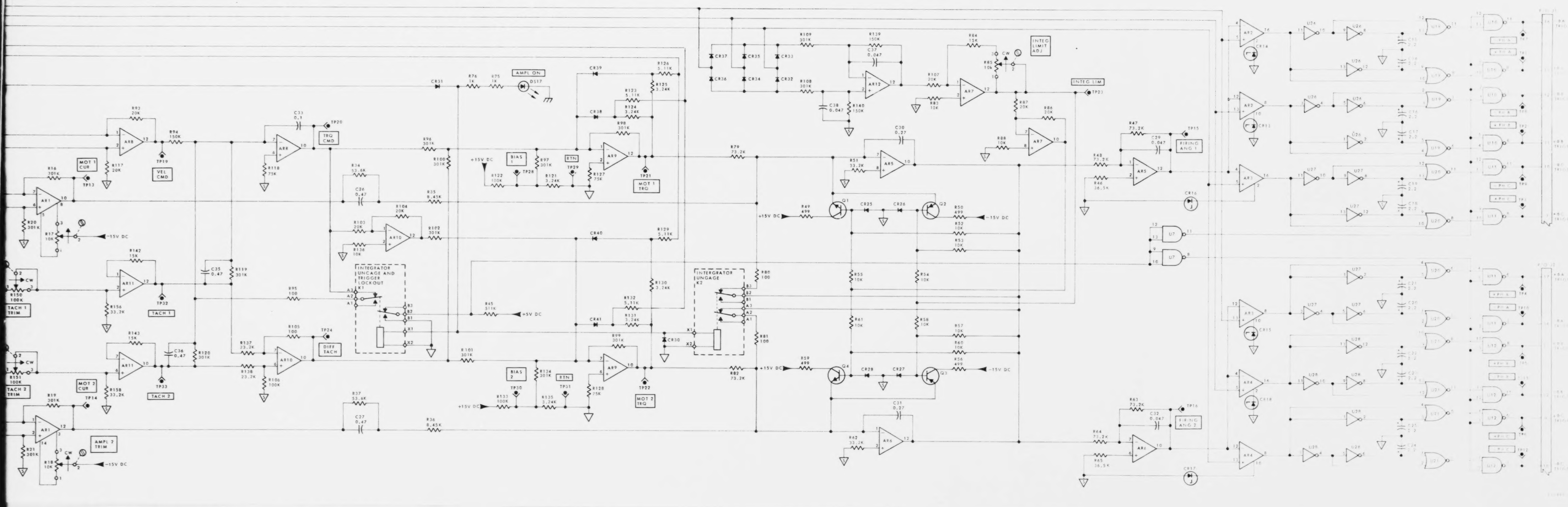
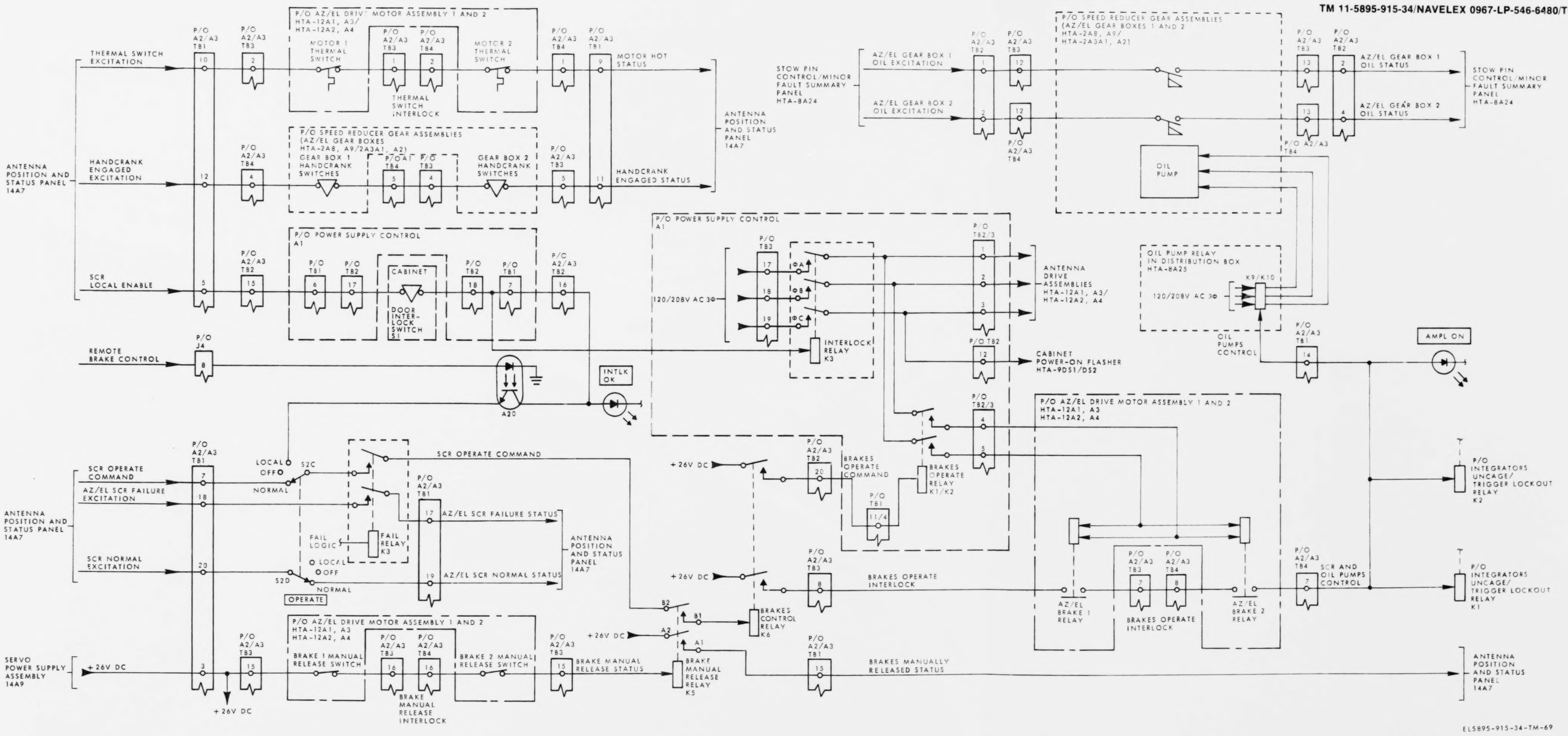
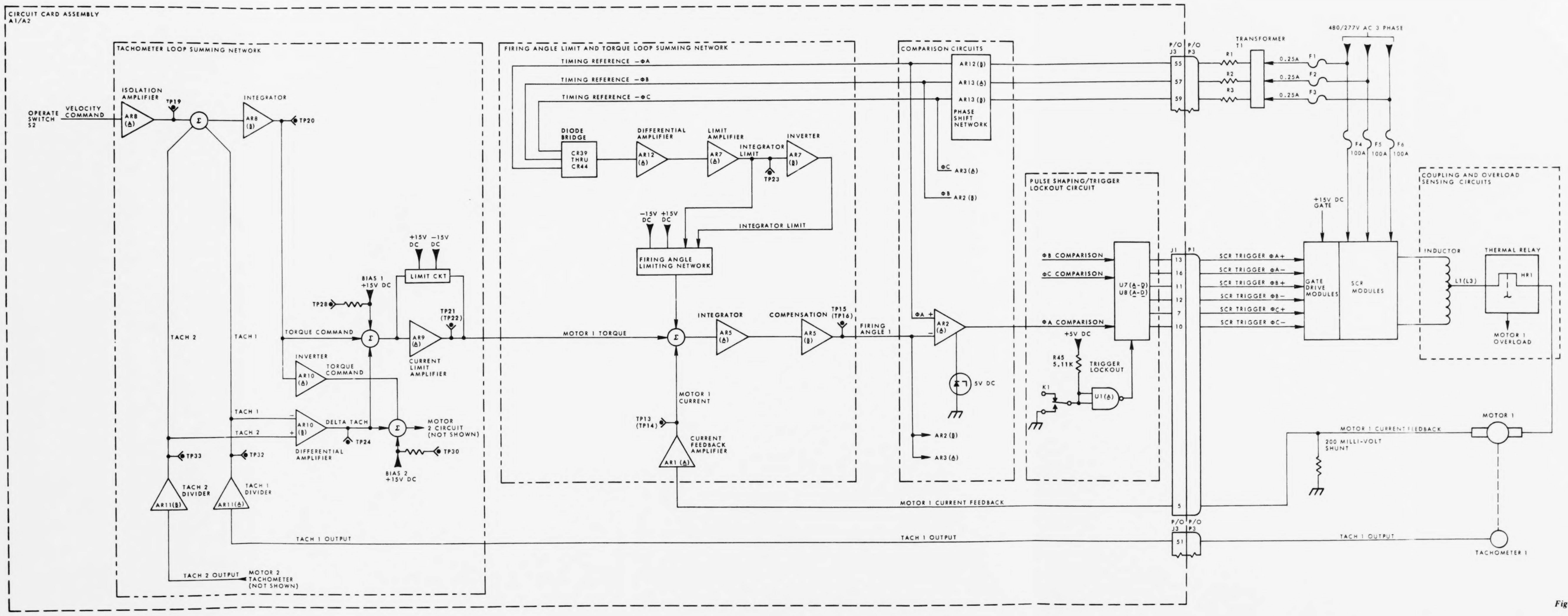

MOT 1 CUR
VEL CMD
TRG CMD
AMPL ON
BIAS 1
MOT 1 TRQ
INTEGRATOR UNCAGE AND TRIGGER LOCKOUT
INTEGRATOR UNCAGE
INTEG LIMIT ADJ
INTEG LIM
TACH 1
TACH 2
DIFF TACH
BIAS 2
MOT 2 TRQ
MOT 2 CUR
AMPL 2 TRIM
TACH 1 TRIM
TACH 2 TRIM
FIRING ANG 1
FIRING ANG 2
+15V DC
-15V DC

Figure FO-21. Circuit card assembly HE 3-9432A1, 9433A1, schematic diagram (sheet 1 of 1)


THERMAL SWITCH EXCITATION
HANDCRANK ENGAGED EXCITATION
SCR LOCAL ENABLE
ANTENNA POSITION AND STATUS PANEL 14A7
P/O A2/A3 TB1
P/O A2/A3 TB3
P/O A2/A3 TB4
P/O A2/A3 TB2
P/O AZ/EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A1, A3/ HTA-12A2, A4
MOTOR 1 THERMAL SWITCH
MOTOR 2 THERMAL SWITCH
THERMAL SWITCH INTERLOCK
MOTOR HOT STATUS
P/O SPEED REDUCER GEAR ASSEMBLIES (AZ/EL GEAR BOXES HTA-2A8, A9/2A3A1, A2)
GEAR BOX 1 HANDCRANK SWITCHES
GEAR BOX 2 HANDCRANK SWITCHES
HANDCRANK ENGAGED STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
P/O POWER SUPPLY CONTROL A1
P/O TB1
P/O TB2
CABINET
DOOR INTERLOCK SWITCH S1
REMOTE BRAKE CONTROL
P/O J4
A20
INTLK OK
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
AZ/EL GEAR BOX 1 OIL EXCITATION
AZ/EL GEAR BOX 2 OIL EXCITATION
P/O SPEED REDUCER GEAR ASSEMBLIES (AZ/EL GEAR BOXES 1 AND 2 HTA-2A8, A9/ HTA-2A3A1, A2)
OIL PUMP
AZ/EL GEAR BOX 1 OIL STATUS
AZ/EL GEAR BOX 2 OIL STATUS
STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL HTA-8A24
P/O POWER SUPPLY CONTROL A1
P/O TB3
120/208V AC 3Φ
ΦA
ΦB
ΦC
INTERLOCK RELAY K3
P/O TB2/3
ANTENNA DRIVE ASSEMBLIES HTA-12A1, A3/ HTA-12A2, A4
P/O TB2
CABINET POWER-ON FLASHER HTA-9DS1/DS2
OIL PUMP RELAY IN DISTRIBUTION BOX HTA-8A25
K9/K10
120/208V AC 3Φ
OIL PUMPS CONTROL
AMPL ON
SCR OPERATE COMMAND
AZ/EL SCR FAILURE EXCITATION
SCR NORMAL EXCITATION
ANTENNA POSITION AND STATUS PANEL 14A7
LOCAL
OFF
NORMAL
S2C
S2D
OPERATE
FAIL LOGIC
FAIL RELAY K3
SCR OPERATE COMMAND
AZ/EL SCR FAILURE STATUS
AZ/EL SCR NORMAL STATUS
ANTENNA POSITION AND STATUS PANEL 14A7
SERVO POWER SUPPLY ASSEMBLY 14A9
+26V DC
P/O AZ/EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A1, A3 HTA-12A2, A4
BRAKE 1 MANUAL RELEASE SWITCH
BRAKE 2 MANUAL RELEASE SWITCH
BRAKE MANUAL RELEASE INTERLOCK
BRAKE MANUAL RELEASE STATUS
BRAKE MANUAL RELEASE RELAY K5
B2
B1
A2
A1
BRAKES CONTROL RELAY K6
BRAKES OPERATE COMMAND
P/O TB1
BRAKES OPERATE RELAY K1/K2
BRAKES OPERATE INTERLOCK
P/O AZ/EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A1, A3 HTA-12A2, A4
AZ/EL BRAKE 1 RELAY
AZ/EL BRAKE 2 RELAY
BRAKES OPERATE INTERLOCK
SCR AND OIL PUMPS CONTROL
P/O INTEGRATORS UNCAGE/ TRIGGER LOCKOUT RELAY K2
P/O INTEGRATORS UNCAGE/ TRIGGER LOCKOUT RELAY K1
BRAKES MANUALLY RELEASED STATUS
ANTENNA POSITION AND STATUS PANEL 14A7

EL5895-915-34-TM-69

Figure FO-22. Electronic control amplifier HTA-9A2, 9A3-to-interfaces, operational interlocks, simplified schematic diagram.


CIRCUIT CARD ASSEMBLY A1/A2
TACHOMETER LOOP SUMMING NETWORK
OPERATE SWITCH S2
VELOCITY COMMAND
ISOLATION AMPLIFIER
AR8 (A)
TP19
Σ
INTEGRATOR
AR8 (B)
TP20
TACH 2
TACH 1
+15V DC
−15V DC
LIMIT CKT
BIAS 1 +15V DC
TP28
TORQUE COMMAND
TP21 (TP22)
AR9 (A)
CURRENT LIMIT AMPLIFIER
INVERTER
AR10 (A)
TORQUE COMMAND
TACH 1
TACH 2
AR10 (B)
DELTA TACH
TP24
DIFFERENTIAL AMPLIFIER
MOTOR 2 CIRCUIT (NOT SHOWN)
TP30
BIAS 2 +15V DC
TP33
TP32
TACH 2 DIVIDER
AR11(B)
TACH 1 DIVIDER
AR11(A)
TACH 1 OUTPUT
TACH 2 OUTPUT
MOTOR 2 TACHOMETER (NOT SHOWN)
FIRING ANGLE LIMIT AND TORQUE LOOP SUMMING NETWORK
TIMING REFERENCE −ΦA
TIMING REFERENCE −ΦB
TIMING REFERENCE −ΦC
DIODE BRIDGE
CR39 THRU CR44
DIFFERENTIAL AMPLIFIER
AR12 (A)
LIMIT AMPLIFIER
AR7 (A)
INTEGRATOR LIMIT
TP23
INVERTER
AR7 (B)
−15V DC
+15V DC
INTEGRATOR LIMIT
FIRING ANGLE LIMITING NETWORK
MOTOR 1 TORQUE
INTEGRATOR
AR5 (A)
COMPENSATION
AR5 (B)
TP15 (TP16)
FIRING ANGLE 1
MOTOR 1 CURRENT
TP13 (TP14)
CURRENT FEEDBACK AMPLIFIER
AR1 (A)
COMPARISON CIRCUITS
AR12 (B)
AR13 (A)
AR13 (B)
PHASE SHIFT NETWORK
ΦC AR3 (A)
ΦB AR2 (B)
ΦA +
AR2 (A)
5V DC
AR2 (B)
AR3 (A)
PULSE SHAPING/TRIGGER LOCKOUT CIRCUIT
ΦB COMPARISON
ΦC COMPARISON
ΦA COMPARISON
U7 (A-D)
U8 (A-D)
+5V DC
R45 5.11K
TRIGGER LOCKOUT
K1
U1 (A)
MOTOR 1 CURRENT FEEDBACK
P/O J3
P/O P3
55
57
59
J1
P1
13
16
11
12
7
10
5
51
TRANSFORMER T1
R1
R2
R3
0.25A
F1
F2
F3
480/277V AC 3 PHASE
F4 100A
F5 100A
F6 100A
+15V DC GATE
SCR TRIGGER ΦA+
SCR TRIGGER ΦA−
SCR TRIGGER ΦB+
SCR TRIGGER ΦB−
SCR TRIGGER ΦC+
SCR TRIGGER ΦC−
GATE DRIVE MODULES
SCR MODULES
COUPLING AND OVERLOAD SENSING CIRCUITS
INDUCTOR
L1 (L3)
THERMAL RELAY
HR1
MOTOR 1 OVERLOAD
MOTOR 1 CURRENT FEEDBACK
200 MILLI-VOLT SHUNT
MOTOR 1
TACH 1 OUTPUT
TACHOMETER 1

NOTES:

1. LETTERS ENCLOSED BY PARENTHESES, AS PART OF IC REFERENCE DESIGNATORS, WERE ASSIGNED ARBITRATILY TO SIMPLIFY THE ANALYSIS DISCUSSION. THESE LETTERS DO NOT APPEAR ON THE SCHEMATIC DIAGRAMS.
2. DISCRETE COMPONENTS ARE SHOWN WHERE NECESSARY TO ELIMINATE CONFUSION, OTHERWISE, THEY ARE OMITTED FOR DIAGRAM CLARITY.
3. UNDERLINE UNDER CAPITAL LETTERS INDICATES LOWER CASE LETTERS.

EL5895-915-34-TM-70

Figure FO-23. Electronic control amplifier HTA-9A2, 9A3, drive power generation, simplified schematic diagram.

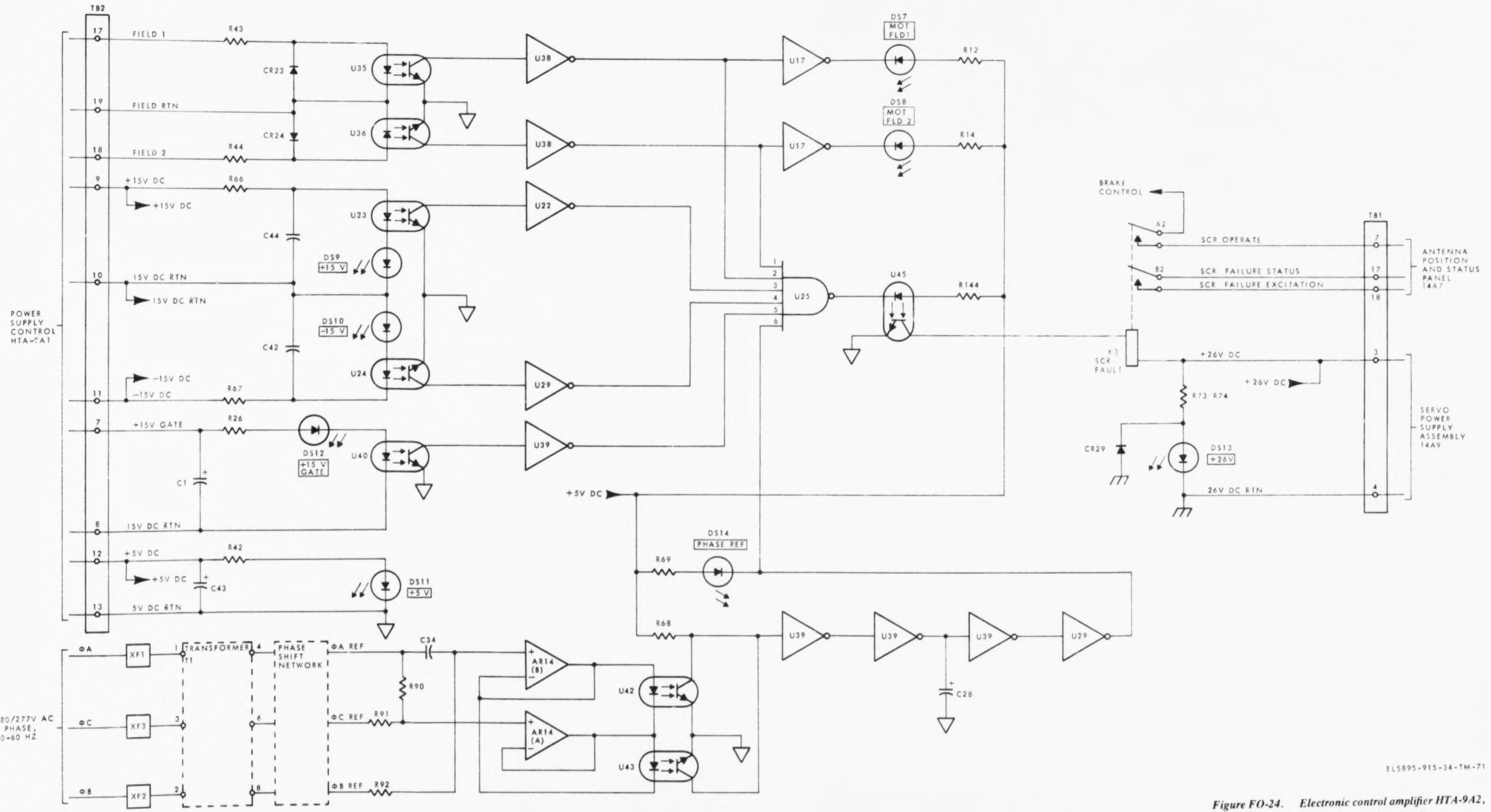
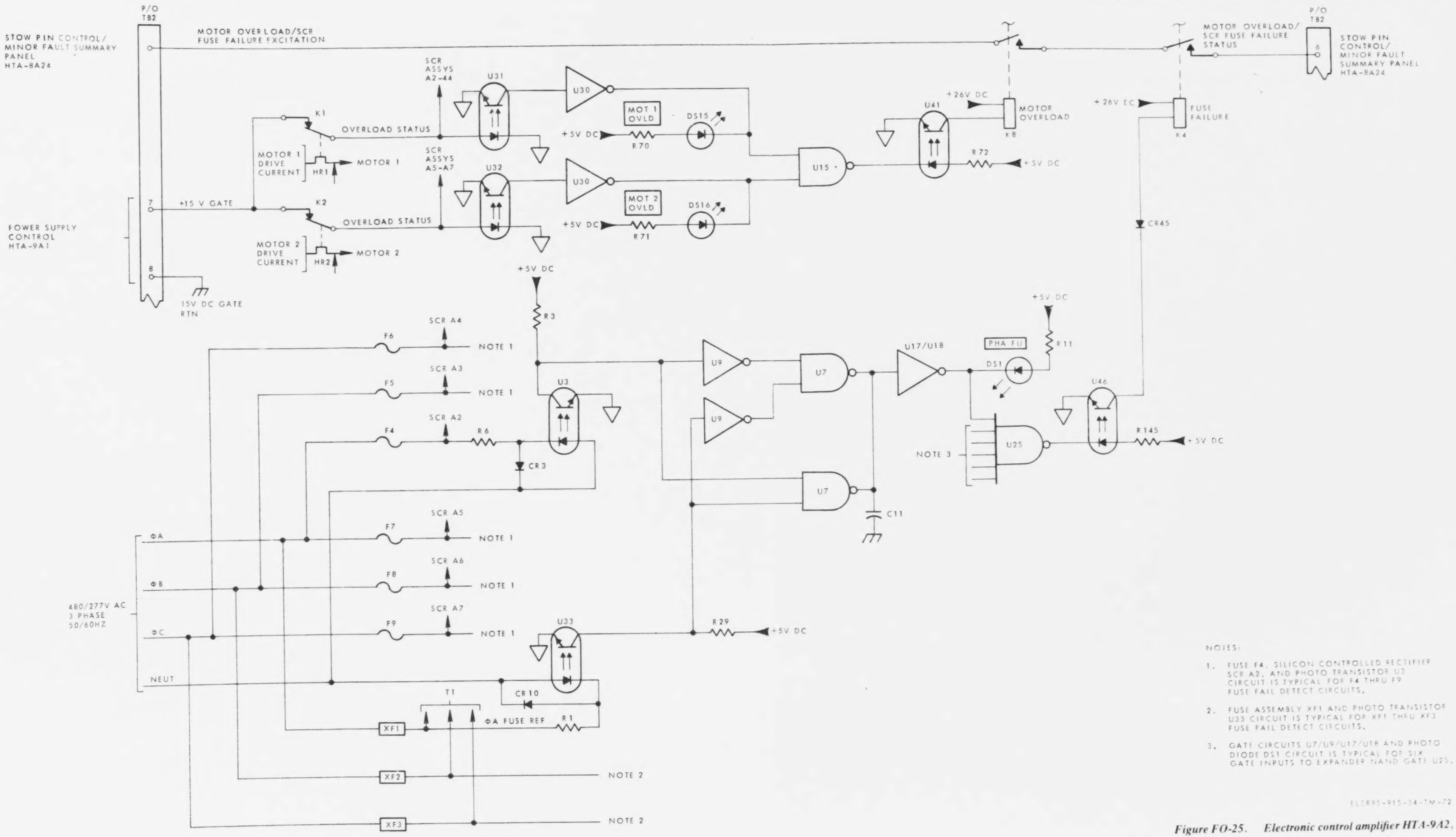

TB2
17
FIELD 1
R43
CR23
U35
19
FIELD RTN
CR24
U36
18
FIELD 2
R44
9
+15V DC
R66
+15V DC
U23
C44
DS9
+15 V
10
15V DC RTN
15V DC RTN
DS10
-15 V
C42
U24
-15V DC
11
-15V DC
R67
7
+15V GATE
R26
DS12
+15 V GATE
U40
C1
8
15V DC RTN
12
+5V DC
R42
+5V DC
C43
DS11
+5 V
13
5V DC RTN
POWER SUPPLY CONTROL HTA-9A1
ΦA
XF1
ΦC
XF3
ΦB
XF2
480/277V AC 3 PHASE, 50-60 HZ
TRANSFORMER T1
PHASE SHIFT NETWORK
ΦA REF
ΦC REF
ΦB REF
C34
R90
R91
R92
AR14 (B)
AR14 (A)
U42
U43
U38
U38
U22
U29
U39
U17
U17
DS7
MOT FLD1
DS8
MOT FLD 2
R12
R14
U25
U45
R144
+5V DC
DS14
PHASE REF
R69
R68
U39
U39
U39
U29
C28
BRAKE CONTROL
A2
B2
SCR OPERATE
SCR FAILURE STATUS
SCR FAILURE EXCITATION
TB1
7
17
18
ANTENNA POSITION AND STATUS PANEL 14A7
K3
SCR FAULT
+26V DC
+26V DC
R73 R74
CR29
DS13
+26V
26V DC RTN
3
4
SERVO POWER SUPPLY ASSEMBLY 14A9
EL5895-915-34-TM-71

Figure FO-24. Electronic control amplifier HTA-9A2, 9A3, major fault detection circuits, simplified schematic diagram.

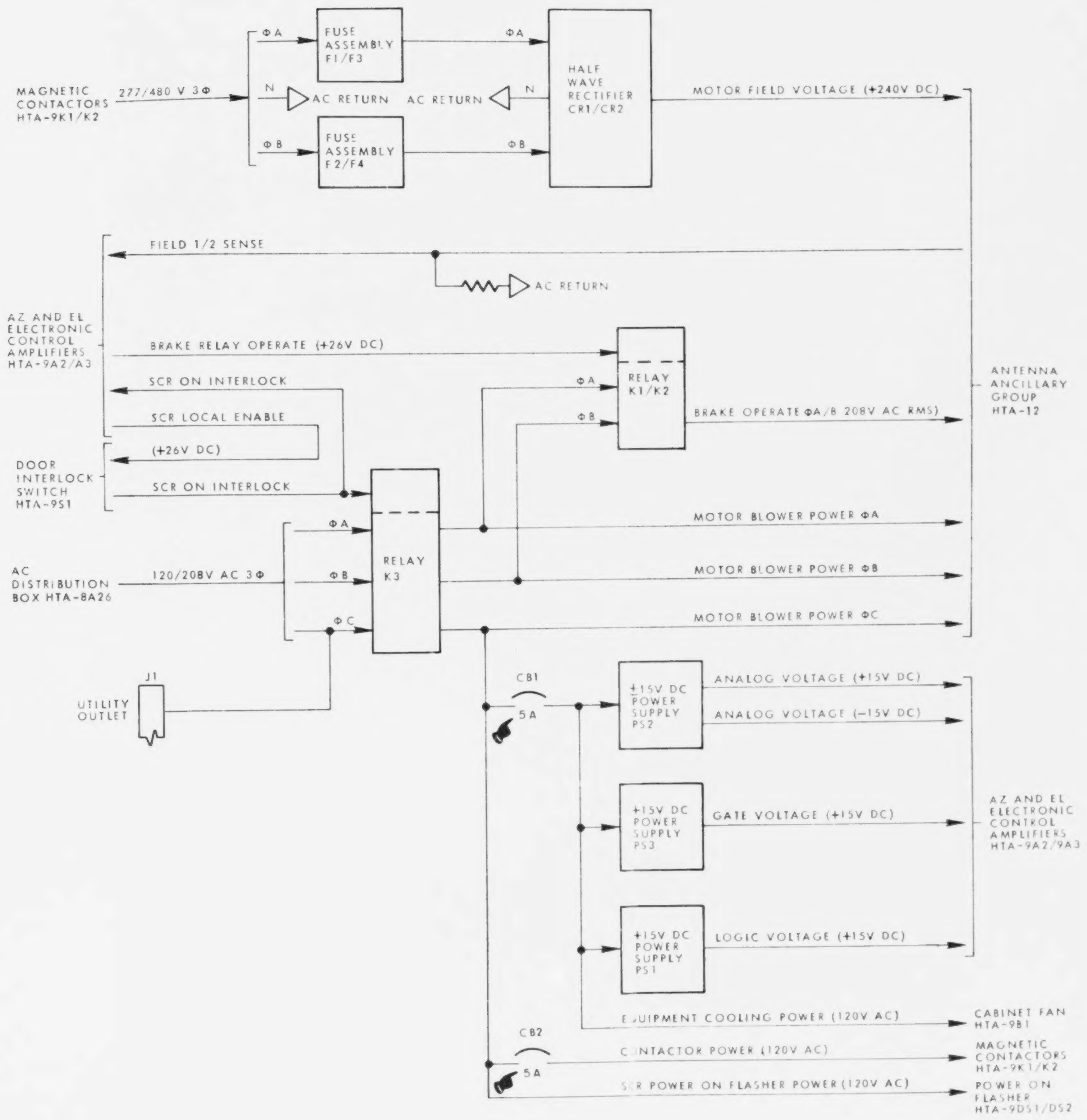

P/O
TB2
STOW PIN CONTROL/
MINOR FAULT SUMMARY
PANEL
HTA-8A24
MOTOR OVERLOAD/SCR
FUSE FAILURE EXCITATION
SCR
ASSYS
A2-44
U31
U30
K1
OVERLOAD STATUS
MOT 1
OVLD
DS15
+5V DC
R70
MOTOR 1
DRIVE
CURRENT
HR1
MOTOR 1
SCR
ASSYS
A5-A7
U32
U30
MOT 2
OVLD
DS16
+5V DC
R71
7
+15 V GATE
K2
OVERLOAD STATUS
POWER SUPPLY
CONTROL
HTA-9A1
MOTOR 2
DRIVE
CURRENT
HR2
MOTOR 2
8
15V DC GATE
RTN
U15
U41
+26V DC
MOTOR
OVERLOAD
K8
R72
+5V DC
+26V DC
FUSE
FAILURE
K4
MOTOR OVERLOAD/
SCR FUSE FAILURE
STATUS
P/O
TB2
6
STOW PIN
CONTROL/
MINOR FAULT
SUMMARY PANEL
HTA-8A24
CR45
+5V DC
R3
SCR A4
F6
NOTE 1
SCR A3
F5
NOTE 1
SCR A2
F4
R6
U3
CR3
U9
U9
U7
U7
C11
U17/U18
PHA FU
DS1
+5V DC
R11
U46
U25
NOTE 3
R145
+5V DC
ΦA
SCR A5
F7
NOTE 1
ΦB
SCR A6
F8
NOTE 1
480/277V AC
3 PHASE
50/60HZ
ΦC
SCR A7
F9
NOTE 1
U33
R29
+5V DC
NEUT
CR10
T1
XF1
ΦA FUSE REF
R1
XF2
NOTE 2
XF3
NOTE 2

NOTES:

1. FUSE F4, SILICON CONTROLLED RECTIFIER SCR A2, AND PHOTO TRANSISTOR U3 CIRCUIT IS TYPICAL FOR F4 THRU F9 FUSE FAIL DETECT CIRCUITS.
2. FUSE ASSEMBLY XF1 AND PHOTO TRANSISTOR U33 CIRCUIT IS TYPICAL FOR XF1 THRU XF3 FUSE FAIL DETECT CIRCUITS.
3. GATE CIRCUITS U7/U9/U17/U18 AND PHOTO DIODE DS1 CIRCUIT IS TYPICAL FOR SIX GATE INPUTS TO EXPANDER NAND GATE U25.

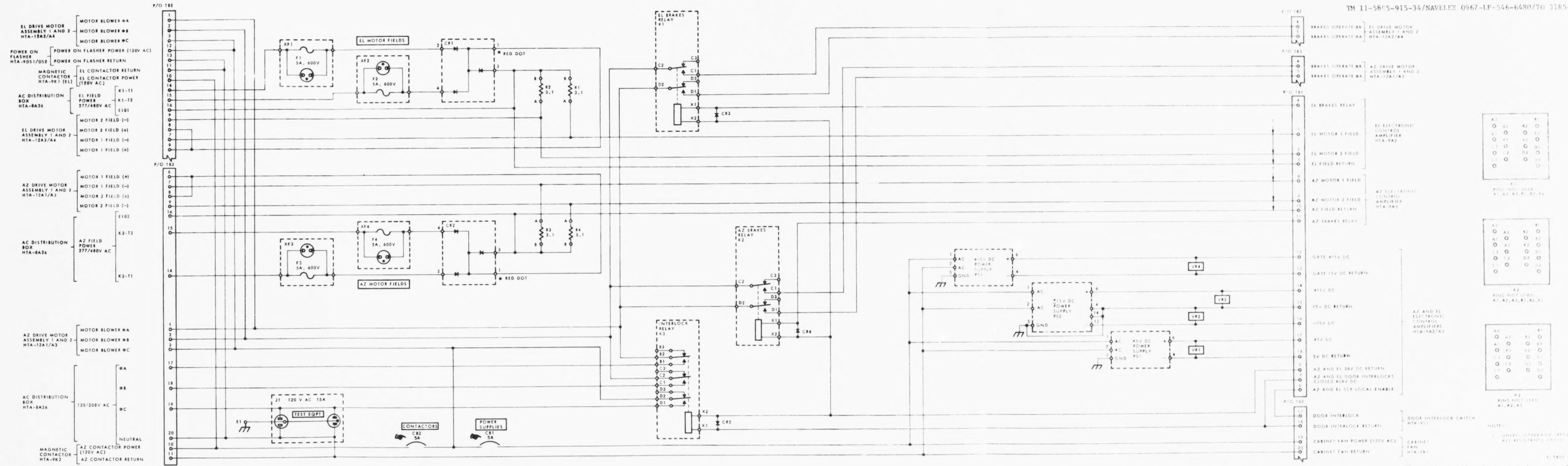
EL5895-915-34-TM-72

Figure FO-25. Electronic control amplifier HTA-9A2, 9A3, minor fault detection circuits, simplified schematic diagram.


MAGNETIC CONTACTORS HTA-9K1/K2
277/480 V 3Φ
ΦA
N
ΦB
FUSE ASSEMBLY F1/F3
FUSE ASSEMBLY F2/F4
AC RETURN
AC RETURN
ΦA
N
ΦB
HALF WAVE RECTIFIER CR1/CR2
MOTOR FIELD VOLTAGE (+240V DC)
FIELD 1/2 SENSE
AC RETURN
AZ AND EL ELECTRONIC CONTROL AMPLIFIERS HTA-9A2/A3
BRAKE RELAY OPERATE (+26V DC)
SCR ON INTERLOCK
SCR LOCAL ENABLE
(+26V DC)
DOOR INTERLOCK SWITCH HTA-9S1
SCR ON INTERLOCK
ΦA
ΦB
RELAY K1/K2
BRAKE OPERATE ΦA/B 208V AC RMS)
ANTENNA ANCILLARY GROUP HTA-12
AC DISTRIBUTION BOX HTA-8A26
120/208V AC 3Φ
ΦA
ΦB
ΦC
RELAY K3
MOTOR BLOWER POWER ΦA
MOTOR BLOWER POWER ΦB
MOTOR BLOWER POWER ΦC
J1
UTILITY OUTLET
CB1
5A
±15V DC POWER SUPPLY PS2
ANALOG VOLTAGE (+15V DC)
ANALOG VOLTAGE (−15V DC)
+15V DC POWER SUPPLY PS3
GATE VOLTAGE (+15V DC)
+15V DC POWER SUPPLY PS1
LOGIC VOLTAGE (+15V DC)
AZ AND EL ELECTRONIC CONTROL AMPLIFIERS HTA-9A2/9A3
EQUIPMENT COOLING POWER (120V AC)
CABINET FAN HTA-9B1
CB2
5A
CONTACTOR POWER (120V AC)
MAGNETIC CONTACTORS HTA-9K1/K2
SCR POWER ON FLASHER POWER (120V AC)
POWER ON FLASHER HTA-9DS1/DS2

EL5895-915-34-TM-104

Figure FO-26. Power supply control HTA-9A1, functional block diagram.

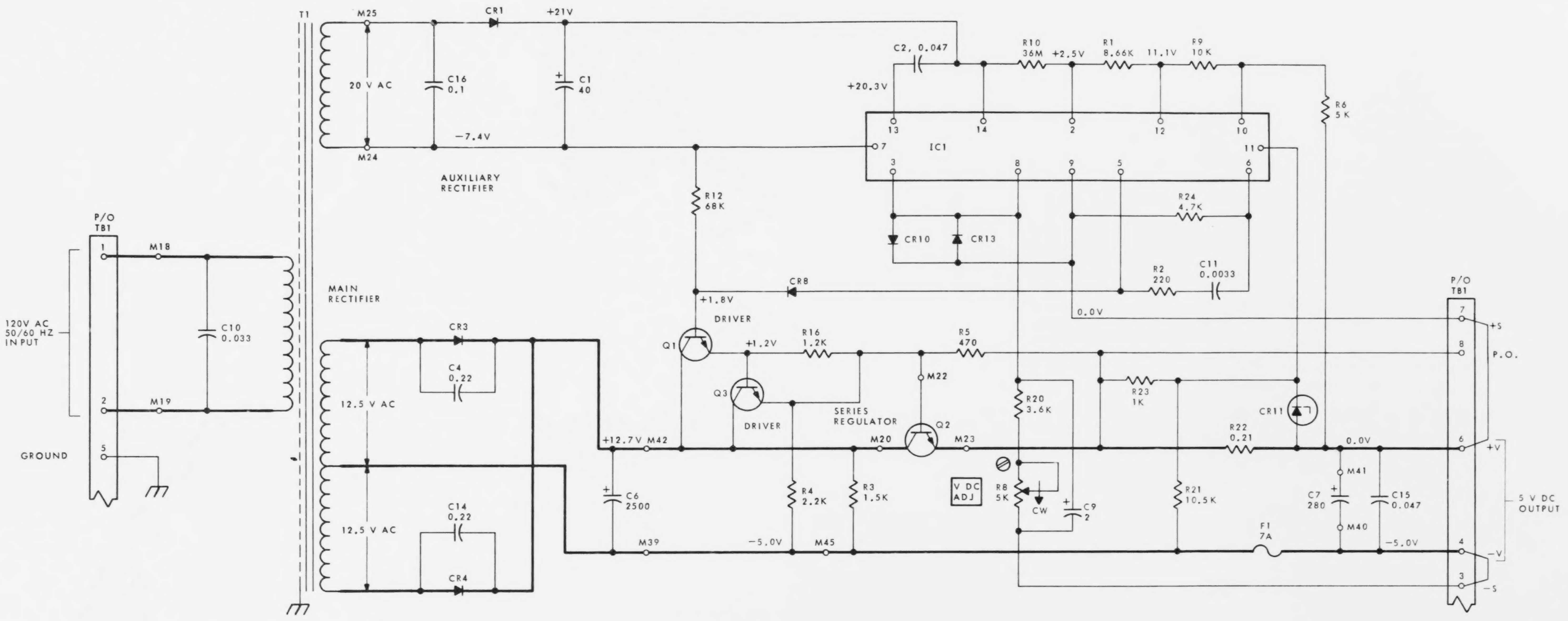

P/O TB2
EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A2/A4
MOTOR BLOWER ΦA
MOTOR BLOWER ΦB
MOTOR BLOWER ΦC
POWER ON FLASHER HTA-9DS1/DS2
POWER ON FLASHER POWER (120V AC)
POWER ON FLASHER RETURN
MAGNETIC CONTACTOR HTA-9K1 (EL)
EL CONTACTOR RETURN
EL CONTACTOR POWER (120V AC)
AC DISTRIBUTION BOX HTA-8A26
EL FIELD POWER 277/480V AC
K1-T1
K1-T2
E101
EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A2/A4
MOTOR 2 FIELD (−)
MOTOR 2 FIELD (+)
MOTOR 1 FIELD (−)
MOTOR 1 FIELD (+)
P/O TB3
AZ DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A1/A3
MOTOR 1 FIELD (+)
MOTOR 1 FIELD (−)
MOTOR 2 FIELD (+)
MOTOR 2 FIELD (−)
AC DISTRIBUTION BOX HTA-8A26
AZ FIELD POWER 277/480V AC
E102
K2-T2
K2-T1
AZ DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A1/A3
MOTOR BLOWER ΦA
MOTOR BLOWER ΦB
MOTOR BLOWER ΦC
AC DISTRIBUTION BOX HTA-8A26
120/208V AC
ΦA
ΦB
ΦC
NEUTRAL
MAGNETIC CONTACTOR HTA-9K2
AZ CONTACTOR POWER (120V AC)
AZ CONTACTOR RETURN
XF1
F1 5A, 600V
XF2
F2 5A, 600V
EL MOTOR FIELDS
CR1
RED DOT
R2 3.1
R1 3.1
XF3
F3 5A, 600V
XF4
F4 5A, 600V
AZ MOTOR FIELDS
CR2
RED DOT
R3 3.1
R4 3.1
EL BRAKES RELAY K1
C1 C2 C3 D1 D2 D3 X1 X2
CR3
AZ BRAKES RELAY K2
CR4
INTERLOCK RELAY K3
B1 B2 B3 C1 C2 C3 D1 D2 D3 X1 X2
CR5
J1 120 V AC 15A
TEST EQPT
E1
CONTACTORS
CB2 5A
POWER SUPPLIES
CB1 5A
+15V DC POWER SUPPLY PS3
±15V DC POWER SUPPLY PS2
+5V DC POWER SUPPLY PS1
AC
AC
GND
VR1
VR2
VR3
VR4
P/O TB2
BRAKES OPERATE ΦB
BRAKES OPERATE ΦA
EL DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A2/A4
P/O TB3
BRAKES OPERATE ΦB
BRAKES OPERATE ΦA
AZ DRIVE MOTOR ASSEMBLY 1 AND 2 HTA-12A1/A3
P/O TB1
EL BRAKES RELAY
EL MOTOR 1 FIELD
EL MOTOR 2 FIELD
EL FIELD RETURN
EL ELECTRONIC CONTROL AMPLIFIER HTA-9A2
AZ MOTOR 1 FIELD
AZ MOTOR 2 FIELD
AZ FIELD RETURN
AZ BRAKES RELAY
AZ ELECTRONIC CONTROL AMPLIFIER HTA-9A3
GATE +15V DC
GATE 15V DC RETURN
+15V DC
15V DC RETURN
−15V DC
+5V DC
5V DC RETURN
AZ AND EL 26V DC RETURN
AZ AND EL DOOR INTERLOCKS CLOSED +26V DC
AZ AND EL SCR LOCAL ENABLE
AZ AND EL ELECTRONIC CONTROL AMPLIFIERS HTA-9A2/A3
P/O TB2
DOOR INTERLOCK
DOOR INTERLOCK RETURN
DOOR INTERLOCK SWITCH HTA-9S1
CABINET FAN POWER (120V AC)
CABINET FAN RETURN
CABINET FAN HTA-9B1
K1 PINS NOT USED: A1,A2,A3,B1,B2,B3
K2 PINS NOT USED: A1,A2,A3,B1,B2,B3
K3 PINS NOT USED: A1,A2,A3

NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS.

EL 5895-915-34/TM-105

Figure FO-27. Power supply control HTA-9A1, schematic diagram.


T1
M25
CR1
+21V
20 V AC
C16
0.1
C1
40
−7.4V
M24
AUXILIARY
RECTIFIER
C2, 0.047
+20.3V
R10
36M
+2.5V
R1
8.66K
11.1V
R9
10K
R6
5K
13
14
2
12
10
7
IC1
11
3
8
9
5
6
R24
4.7K
CR10
CR13
R2
220
C11
0.0033
R12
68K
CR8
+1.8V
DRIVER
0.0V
P/O
TB1
1
M18
120V AC
50/60 HZ
INPUT
C10
0.033
2
M19
GROUND
5
MAIN
RECTIFIER
CR3
C4
0.22
12.5 V AC
C14
0.22
12.5 V AC
CR4
Q1
+1.2V
R16
1.2K
R5
470
Q3
M22
DRIVER
SERIES
REGULATOR
Q2
+12.7V
M42
M20
M23
R20
3.6K
R23
1K
CR11
R22
0.21
0.0V
C6
2500
R4
2.2K
R3
1.5K
V DC
ADJ
R8
5K
CW
C9
2
R21
10.5K
M41
C7
280
M40
C15
0.047
M39
−5.0V
M45
F1
7A
−5.0V
P/O
TB1
7
+S
8
P.O.
6
+V
5 V DC
OUTPUT
4
−V
3
−S

NOTES:

1. UNLESS OTHERWISE SPECIFIED,
ALL RESISTANCE VALUES ARE IN OHMS;
ALL CAPACITANCE VALUES ARE IN MICROFARADS.

2. SYMBOLS:

⦶ INDICATES ADJUSTMENT OR CALIBRATION CONTROL.

—o— INDICATES TERMINAL ON PRINTED CIRCUIT BOARD.

3. CONDITIONS FOR CIRCUIT MEASUREMENTS:

INPUT: 120V AC, 60HZ.

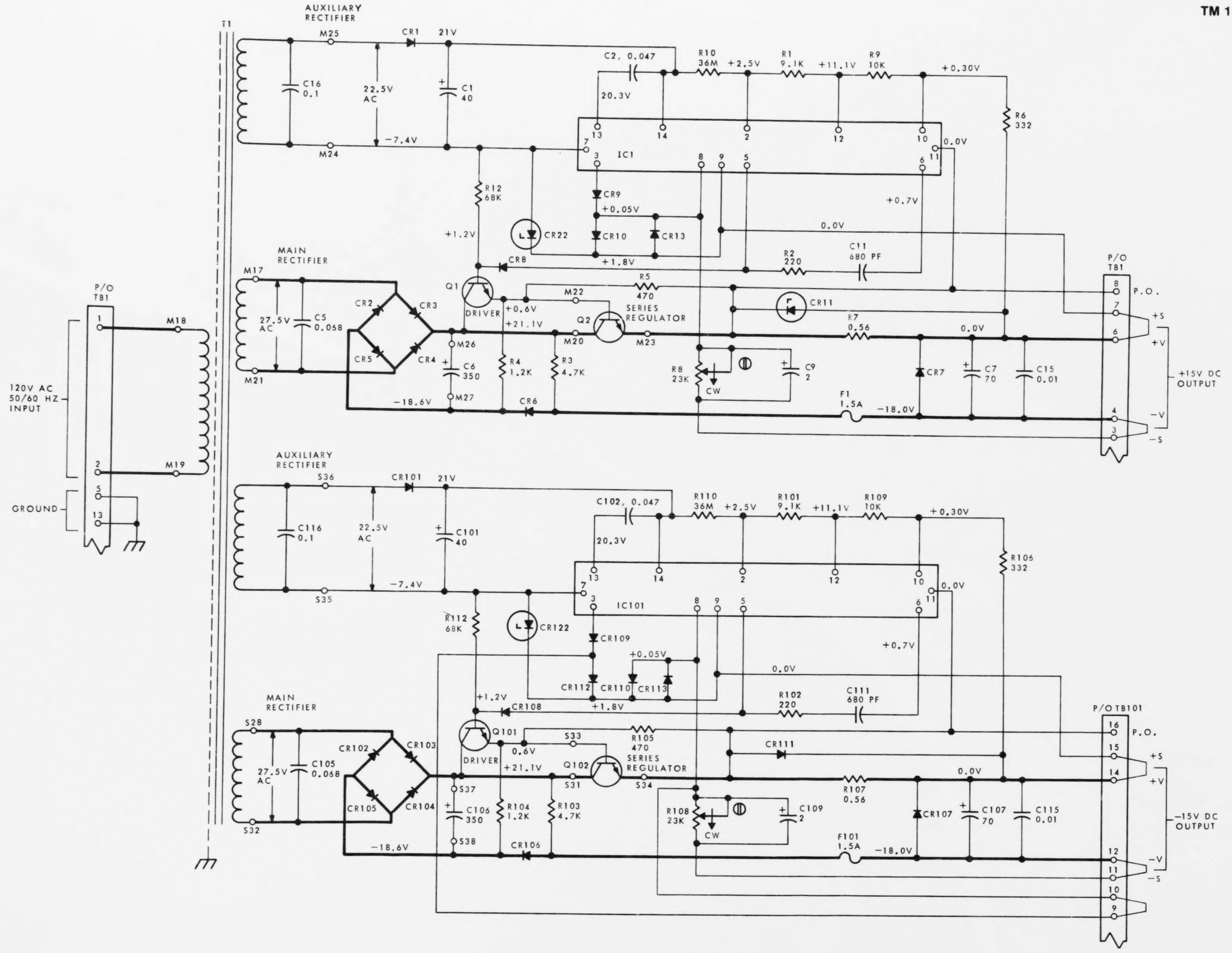
OUTPUT: NOMINAL 5V DC.

INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC.

DC MEASUREMENTS TAKEN WITH 20,000 OHM/VOLT VOLTMETER BETWEEN +S (TERM 7) AND INDICATED POINTS.
+S AND +V SHORTED, −S AND −V SHORTED

EL5895-915-35-TM-75

Figure FO-28. +5 V dc power supply HTA-9A1PS1, schematic diagram.


T1
AUXILIARY RECTIFIER
M25
CR1
21V
C16 0.1
22.5V AC
C1 40
-7.4V
M24
C2, 0.047
20.3V
R10 36M
+2.5V
R1 9.1K
+11.1V
R9 10K
+0.30V
R6 332
IC1
13
14
2
12
10
7
3
8
9
5
6
11
0.0V
R12 68K
CR9
+0.05V
CR10
CR13
CR22
+1.2V
+0.7V
0.0V
CR8
+1.8V
R2 220
C11 680 PF
MAIN RECTIFIER
M17
27.5V AC
C5 0.068
CR2
CR3
CR5
CR4
Q1
DRIVER
+0.6V
+21.1V
M22
R5 470
SERIES REGULATOR
Q2
M20
M23
CR11
R7 0.56
0.0V
M26
C6 350
M27
R4 1.2K
R3 4.7K
R8 23K
CW
C9 2
CR7
C7 70
C15 0.01
M21
-18.6V
CR6
F1 1.5A
-18.0V
P/O TB1
8
P.O.
7
+S
6
+V
+15V DC OUTPUT
4
-V
3
-S
P/O TB1
1
M18
120V AC 50/60 HZ INPUT
2
M19
GROUND
5
13
AUXILIARY RECTIFIER
S36
CR101
21V
C116 0.1
22.5V AC
C101 40
-7.4V
S35
C102, 0.047
20.3V
R110 36M
+2.5V
R101 9.1K
+11.1V
R109 10K
+0.30V
R106 332
IC101
13
14
2
12
10
7
3
8
9
5
6
11
0.0V
R112 68K
CR122
CR109
+0.05V
+0.7V
0.0V
CR112
CR110
CR113
+1.2V
CR108
+1.8V
R102 220
C111 680 PF
MAIN RECTIFIER
S28
27.5V AC
C105 0.068
CR102
CR103
CR105
CR104
Q101
DRIVER
0.6V
+21.1V
S33
R105 470
SERIES REGULATOR
Q102
S31
S34
CR111
R107 0.56
0.0V
S37
C106 350
S38
R104 1.2K
R103 4.7K
R108 23K
CW
C109 2
CR107
C107 70
C115 0.01
S32
-18.6V
CR106
F101 1.5A
-18.0V
P/O TB101
16
P.O.
15
+S
14
+V
-15V DC OUTPUT
12
-V
11
-S
10
9

NOTES:

1. UNLESS OTHERWISE SPECIFIED,
ALL RESISTANCE VALUES ARE IN OHMS;
ALL CAPACITANCE VALUES ARE IN MICROFARADS.

2. SYMBOLS:

⦶ INDICATES ADJUSTMENT OR CALIBRATION CONTROL.

—o— INDICATES TERMINAL ON PRINTED CIRCUIT BOARD.

3. CONDITIONS FOR CIRCUIT MEASUREMENTS:

INPUT: 120V AC, 60 HZ.

OUTPUT: NOMINAL +15/-15V DC.

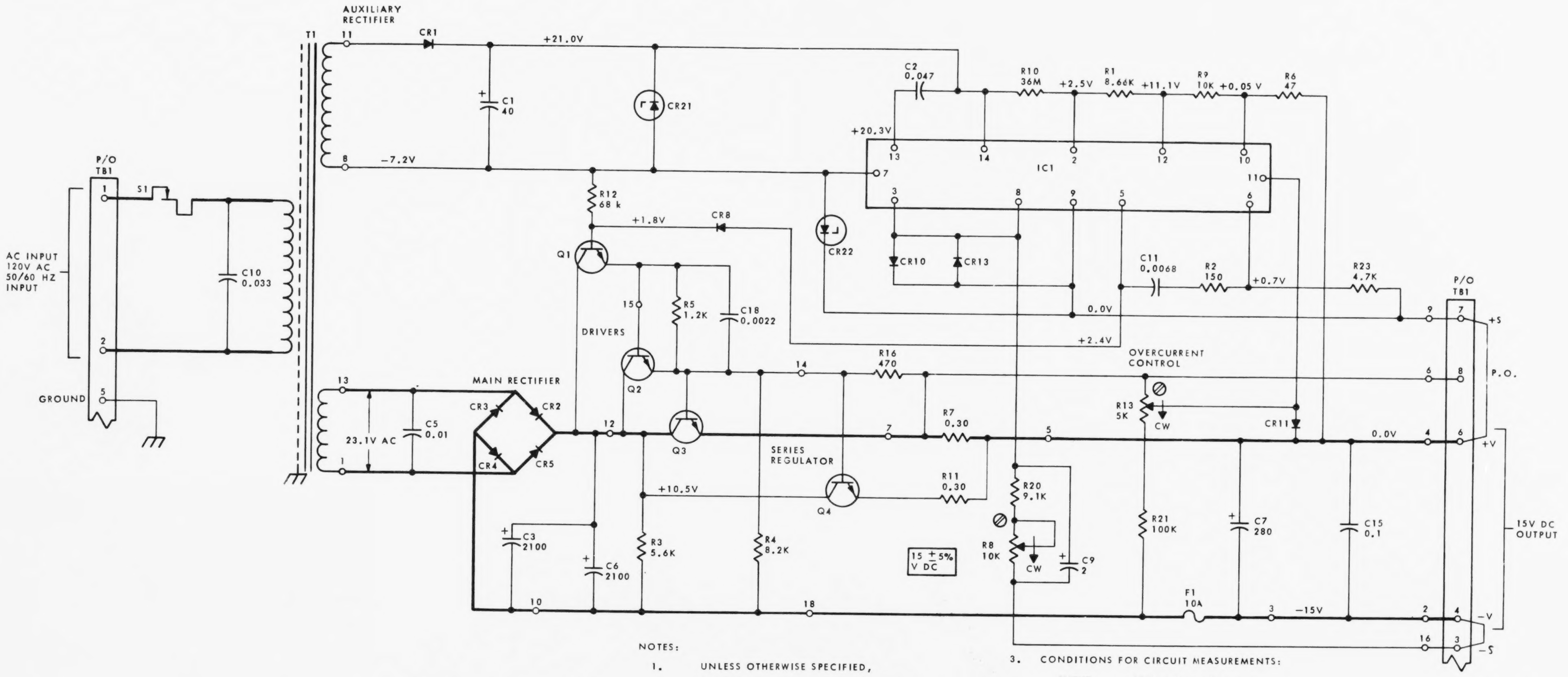
INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC.

DC MEASUREMENTS TAKEN WITH 20,000 OHM/VOLT VOLTMETER BETWEEN +S (TERM 15) AND INDICATED POINTS.

+S AND +V SHORTED, -S AND -V SHORTED, TERM 9 AND TERM 10 SHORTED.

EL5895-915-34-TM-76

Figure FO-29. +15 V dc power supply HTA-9A1PS2, schematic diagram.


AUXILIARY RECTIFIER
T1
11
CR1
+21.0V
C1 40
CR21
C2 0.047
R10 36M
+2.5V
R1 8.66K
+11.1V
R9 10K
+0.05 V
R6 47
+20.3V
13
14
2
12
10
IC1
7
11
3
8
9
5
6
8
−7.2V
R12 68 k
+1.8V
CR8
CR22
CR10
CR13
C11 0.0068
R2 150
+0.7V
R23 4.7K
0.0V
+2.4V
P/O TB1
1
S1
C10 0.033
AC INPUT 120V AC 50/60 HZ INPUT
2
5
GROUND
Q1
15
R5 1.2K
C18 0.0022
DRIVERS
Q2
14
R16 470
OVERCURRENT CONTROL
R13 5K
CW
CR11
13
23.1V AC
C5 0.01
1
MAIN RECTIFIER
CR3
CR2
CR4
CR5
12
Q3
7
R7 0.30
5
0.0V
SERIES REGULATOR
Q4
+10.5V
R11 0.30
R20 9.1K
R8 10K
CW
C9 2
15 ± 5% V DC
C3 2100
C6 2100
R3 5.6K
R4 8.2K
R21 100K
C7 280
C15 0.1
10
18
F1 10A
3
−15V
P/O TB1
9
7
+S
6
8
P.O.
4
6
+V
15V DC OUTPUT
2
4
−V
16
3
−S

NOTES:

1. UNLESS OTHERWISE SPECIFIED,
   ALL RESISTANCE VALUES ARE IN OHMS;
   ALL CAPACITANCE VALUES ARE IN MICROFARADS.

2. SYMBOLS:
   ⊘ INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   -o- INDICATES TERMINAL ON PRINTED CIRCUIT BOARD B.

3. CONDITIONS FOR CIRCUIT MEASUREMENTS:
   INPUT: 120V AC, 60HZ.
   OUTPUT: NOMINAL 15V DC.
   INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC.
   DC MEASUREMENTS TAKEN WITH 20,000 OHM/VOTL VOLTMETER BETWEEN +S (TERM 7) AND INDICATED POINTS.
   +S AND +V SHORTED, −S AND −V SHORTED.

EL5895-915-34-TM-77

Figure FO-30. +15 V dc gate power supply HTA-9A1PS3, schematic diagram.

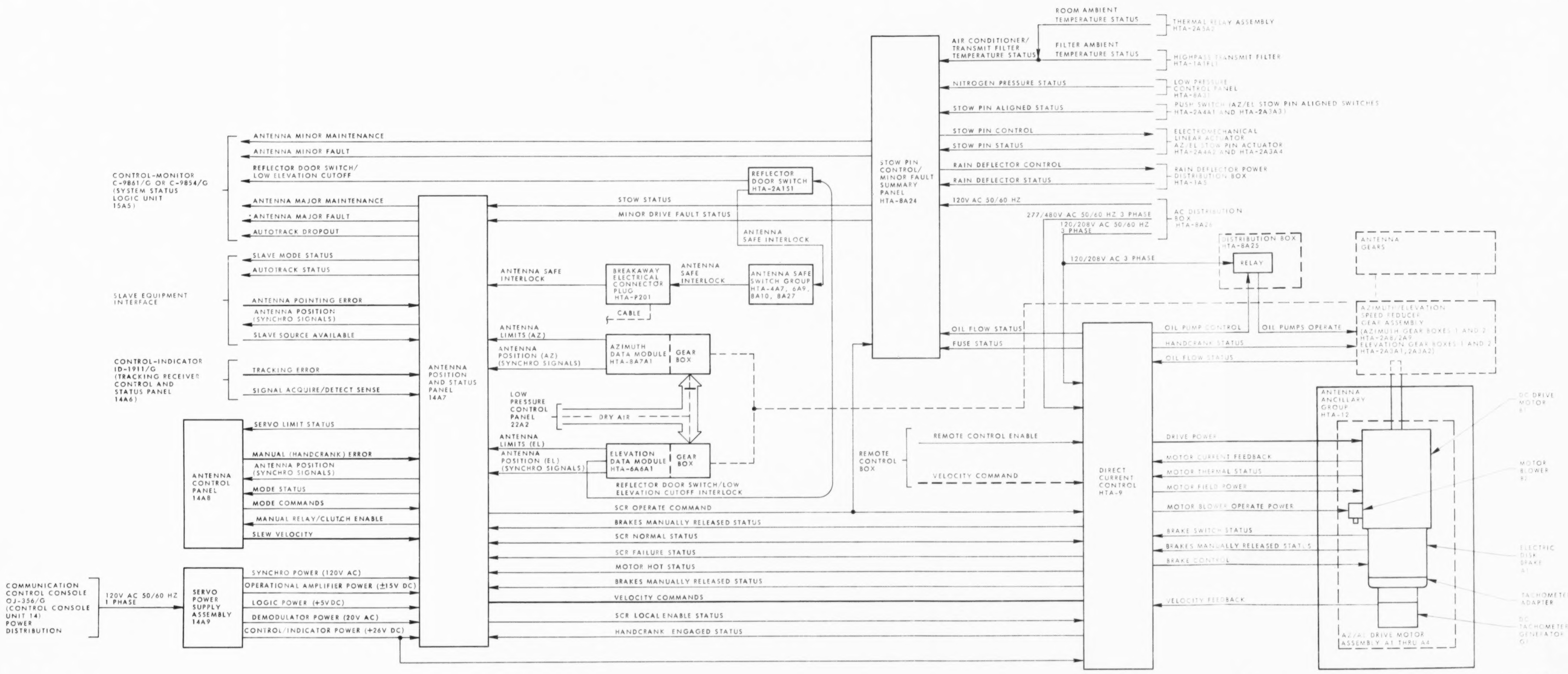
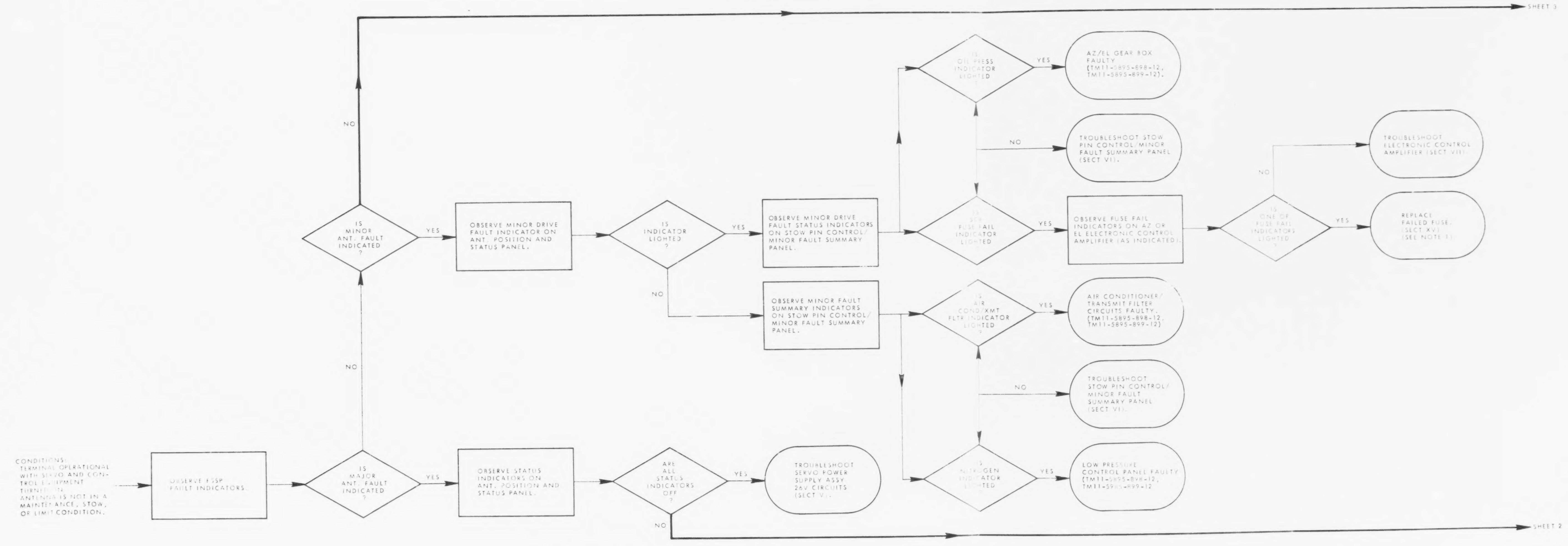

CONTROL-MONITOR C-9861/G OR C-9854/G (SYSTEM STATUS LOGIC UNIT 15A5)
ANTENNA MINOR MAINTENANCE
ANTENNA MINOR FAULT
REFLECTOR DOOR SWITCH/ LOW ELEVATION CUTOFF
ANTENNA MAJOR MAINTENANCE
ANTENNA MAJOR FAULT
AUTOTRACK DROPOUT
SLAVE EQUIPMENT INTERFACE
SLAVE MODE STATUS
AUTOTRACK STATUS
ANTENNA POINTING ERROR
ANTENNA POSITION (SYNCHRO SIGNALS)
SLAVE SOURCE AVAILABLE
CONTROL-INDICATOR ID-1911/G (TRACKING RECEIVER CONTROL AND STATUS PANEL 14A6)
TRACKING ERROR
SIGNAL ACQUIRE/DETECT SENSE
ANTENNA CONTROL PANEL 14A8
SERVO LIMIT STATUS
MANUAL (HANDCRANK) ERROR
ANTENNA POSITION (SYNCHRO SIGNALS)
MODE STATUS
MODE COMMANDS
MANUAL RELAY/CLUTCH ENABLE
SLEW VELOCITY
COMMUNICATION CONTROL CONSOLE OJ-356/G (CONTROL CONSOLE UNIT 14) POWER DISTRIBUTION
120V AC 50/60 HZ 1 PHASE
SERVO POWER SUPPLY ASSEMBLY 14A9
SYNCHRO POWER (120V AC)
OPERATIONAL AMPLIFIER POWER (±15V DC)
LOGIC POWER (+5VDC)
DEMODULATOR POWER (20V AC)
CONTROL/INDICATOR POWER (+26V DC)
ANTENNA POSITION AND STATUS PANEL 14A7
REFLECTOR DOOR SWITCH HTA-2A1S1
STOW STATUS
MINOR DRIVE FAULT STATUS
ANTENNA SAFE INTERLOCK
ANTENNA SAFE INTERLOCK
BREAKAWAY ELECTRICAL CONNECTOR PLUG HTA-P201
ANTENNA SAFE INTERLOCK
ANTENNA SAFE SWITCH GROUP HTA-4A7, 6A9, 8A10, 8A27
CABLE
ANTENNA LIMITS (AZ)
ANTENNA POSITION (AZ) (SYNCHRO SIGNALS)
AZIMUTH DATA MODULE HTA-8A7A1
GEAR BOX
LOW PRESSURE CONTROL PANEL 22A2
DRY AIR
ANTENNA LIMITS (EL)
ANTENNA POSITION (EL) (SYNCHRO SIGNALS)
ELEVATION DATA MODULE HTA-6A6A1
GEAR BOX
REFLECTOR DOOR SWITCH/LOW ELEVATION CUTOFF INTERLOCK
SCR OPERATE COMMAND
BRAKES MANUALLY RELEASED STATUS
SCR NORMAL STATUS
SCR FAILURE STATUS
MOTOR HOT STATUS
BRAKES MANUALLY RELEASED STATUS
VELOCITY COMMANDS
SCR LOCAL ENABLE STATUS
HANDCRANK ENGAGED STATUS
STOW PIN CONTROL/ MINOR FAULT SUMMARY PANEL HTA-8A24
ROOM AMBIENT TEMPERATURE STATUS
THERMAL RELAY ASSEMBLY HTA-2A5A2
AIR CONDITIONER/ TRANSMIT FILTER TEMPERATURE STATUS
FILTER AMBIENT TEMPERATURE STATUS
HIGHPASS TRANSMIT FILTER HTA-1A1FL1
NITROGEN PRESSURE STATUS
LOW PRESSURE CONTROL PANEL HTA-8A31
STOW PIN ALIGNED STATUS
PUSH SWITCH (AZ/EL STOW PIN ALIGNED SWITCHES HTA-2A4A1 AND HTA-2A3A3)
STOW PIN CONTROL
STOW PIN STATUS
ELECTROMECHANICAL LINEAR ACTUATOR AZ/EL STOW PIN ACTUATOR HTA-2A4A2 AND HTA-2A3A4
RAIN DEFLECTOR CONTROL
RAIN DEFLECTOR STATUS
RAIN DEFLECTOR POWER DISTRIBUTION BOX HTA-1A5
120V AC 50/60 HZ
277/480V AC 50/60 HZ 3 PHASE
120/208V AC 50/60 HZ 3 PHASE
AC DISTRIBUTION BOX HTA-8A26
DISTRIBUTION BOX HTA-8A25
RELAY
120/208V AC 3 PHASE
ANTENNA GEARS
OIL FLOW STATUS
FUSE STATUS
OIL PUMP CONTROL
OIL PUMPS OPERATE
HANDCRANK STATUS
OIL FLOW STATUS
AZIMUTH/ELEVATION SPEED REDUCER GEAR ASSEMBLY (AZIMUTH GEAR BOXES 1 AND 2 HTA-2A8/2A9 ELEVATION GEAR BOXES 1 AND 2 HTA-2A3A1, 2A3A2)
REMOTE CONTROL BOX
REMOTE CONTROL ENABLE
VELOCITY COMMAND
DIRECT CURRENT CONTROL HTA-9
DRIVE POWER
MOTOR CURRENT FEEDBACK
MOTOR THERMAL STATUS
MOTOR FIELD POWER
MOTOR BLOWER OPERATE POWER
BRAKE SWITCH STATUS
BRAKES MANUALLY RELEASED STATUS
BRAKE CONTROL
VELOCITY FEEDBACK
ANTENNA ANCILLARY GROUP HTA-12
AZ/EL DRIVE MOTOR ASSEMBLY A1 THRU A4
DC DRIVE MOTOR B1
MOTOR BLOWER B2
ELECTRIC DISK BRAKE A1
TACHOMETER ADAPTER
DC TACHOMETER-GENERATOR G1
5895-915-34-TM-51

Figure FO-31. Servo and control equipment, block diagram.


SHEET 3
CONDITIONS:
TERMINAL OPERATIONAL WITH SERVO AND CONTROL EQUIPMENT TURNED ON.
ANTENNA IS NOT IN A MAINTENANCE, STOW, OR LIMIT CONDITION.
OBSERVE FSSP FAULT INDICATORS.
IS MAJOR ANT. FAULT INDICATED ?
YES
NO
OBSERVE STATUS INDICATORS ON ANT. POSITION AND STATUS PANEL.
ARE ALL STATUS INDICATORS OFF ?
YES
NO
TROUBLESHOOT SERVO POWER SUPPLY ASSY 26V CIRCUITS (SECT V).
SHEET 2
IS MINOR ANT. FAULT INDICATED ?
YES
NO
OBSERVE MINOR DRIVE FAULT INDICATOR ON ANT. POSITION AND STATUS PANEL.
IS INDICATOR LIGHTED ?
YES
NO
OBSERVE MINOR DRIVE FAULT STATUS INDICATORS ON STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL.
OBSERVE MINOR FAULT SUMMARY INDICATORS ON STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL.
IS OIL PRESS INDICATOR LIGHTED ?
YES
AZ/EL GEAR BOX FAULTY (TM11-5895-898-12, TM11-5895-899-12).
NO
TROUBLESHOOT STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL (SECT VI).
IS SCR FUSE FAIL INDICATOR LIGHTED ?
YES
OBSERVE FUSE FAIL INDICATORS ON AZ OR EL ELECTRONIC CONTROL AMPLIFIER (AS INDICATED).
IS ONE OF FUSE FAIL INDICATORS LIGHTED ?
YES
REPLACE FAILED FUSE. (SECT XV) (SEE NOTE 1)
NO
TROUBLESHOOT ELECTRONIC CONTROL AMPLIFIER (SECT VII).
IS AIR COND/XMT FLTR INDICATOR LIGHTED ?
YES
AIR CONDITIONER/TRANSMIT FILTER CIRCUITS FAULTY. (TM11-5895-898-12, TM11-5895-899-12)
NO
TROUBLESHOOT STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL (SECT VI).
IS NITROGEN INDICATOR LIGHTED ?
YES
LOW PRESSURE CONTROL PANEL FAULTY (TM11-5895-898-12, TM11-5895-899-12

NOTES:
1. IF FUSE FAILURE IS A REPEAT, TROUBLESHOOT ELECTRONIC CONTROL AMPLIFIER (SECT VII) AND REPLACE FAILED FUSE (SECT XV).

ABBREVIATIONS

FSSP - FAULT & SYSTEM STATUS PANEL
ANT - ANTENNA
ASSY - ASSEMBLY
AZ - AZIMUTH AXIS
EL - ELEVATION AXIS
SECT - SECTION

EL5895-915-34-TM-80 ①

Figure FO-32. Servo and control equipment group, troubleshooting flowchart (sheet 1 of 3).

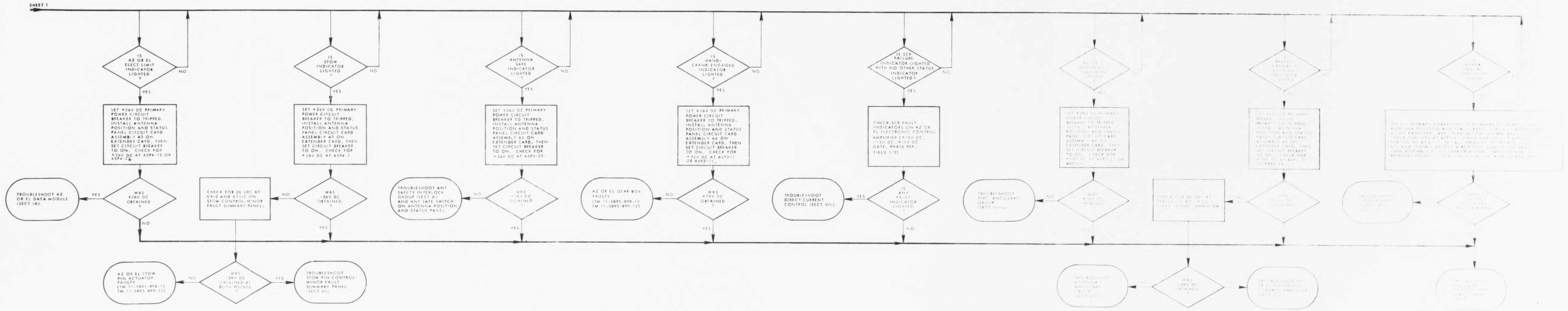

SHEET 1
IS AZ OR EL ELECT LIMIT INDICATOR LIGHTED ?
NO
YES
SET +26V DC PRIMARY POWER CIRCUIT BREAKER TO TRIPPED. INSTALL ANTENNA POSITION AND STATUS PANEL CIRCUIT CARD ASSEMBLY A5 ON EXTENDER CARD, THEN SET CIRCUIT BREAKER TO ON. CHECK FOR +26V DC AT A5P4-15 OR A5P4-23.
WAS +26V DC OBTAINED ?
YES
TROUBLESHOOT AZ OR EL DATA MODULE (SECT IX).
NO
IS STOW INDICATOR LIGHTED ?
NO
YES
SET +26V DC PRIMARY POWER CIRCUIT BREAKER TO TRIPPED. INSTALL ANTENNA POSITION AND STATUS PANEL CIRCUIT CARD ASSEMBLY A5 ON EXTENDER CARD, THEN SET CIRCUIT BREAKER TO ON. CHECK FOR +26V DC AT A5P4-7.
WAS -26V DC OBTAINED ?
NO
CHECK FOR 26 VDC AT K9-2 AND K13-2 ON STOW CONTROL/MINOR FAULT SUMMARY PANEL.
YES
WAS -26V DC OBTAINED AT BOTH POINTS ?
NO
AZ OR EL STOW PIN ACTUATOR FAULTY (TM 11-5895-898-12 TM 11-5895-899-12)
YES
TROUBLESHOOT STOW PIN CONTROL/MINOR FAULT SUMMARY PANEL (SECT VI).
IS ANTENNA SAFE INDICATOR LIGHTED ?
NO
YES
SET +26V DC PRIMARY POWER CIRCUIT BREAKER TO TRIPPED. INSTALL ANTENNA POSITION AND STATUS PANEL CIRCUIT CARD ASSEMBLY A5 ON EXTENDER CARD, THEN SET CIRCUIT BREAKER TO ON. CHECK FOR +26V DC AT A5P3-23.
WAS +26V DC OBTAINED ?
NO
TROUBLESHOOT ANT SAFETY INTERLOCK GROUP (SECT X) AND ANT SAFE SWITCH ON ANTENNA POSITION AND STATUS PANEL.
YES
IS HAND-CRANK ENGAGED INDICATOR LIGHTED ?
NO
YES
SET +26V DC PRIMARY POWER CIRCUIT BREAKER TO TRIPPED. INSTALL ANTENNA POSITION AND STATUS PANEL CIRCUIT CARD ASSEMBLY A6 ON EXTENDER CARD, THEN SET CIRCUIT BREAKER TO ON. CHECK FOR +26V DC AT A6P2-1 OR A6P2-11.
WAS +26V DC OBTAINED ?
NO
AZ OR EL GEAR BOX FAULTY (TM 11-5895-898-12 TM 11-5895-899-12)
YES
IS SCR FAILURE INDICATOR LIGHTED WITH NO OTHER STATUS INDICATOR LIGHTED?
NO
YES
CHECK SCR FAULT INDICATORS ON AZ OR EL ELECTRONIC CONTROL AMPLIFIER (+15V DC, -15V DC, +15V DC GATE, PHASE REF, FIELD 1/2)
IS ANY FAULT INDICATOR LIGHTED ?
YES
TROUBLESHOOT DIRECT CURRENT CONTROL (SECT VII).
NO
IS AZ OR EL MOTOR HOT INDICATOR LIGHTED ?
NO
YES
SET +26V DC PRIMARY POWER CIRCUIT BREAKER TO TRIPPED. INSTALL ANTENNA POSITION AND STATUS PANEL CIRCUIT CARD ASSEMBLY A6 ON EXTENDER CARD, THEN SET CIRCUIT BREAKER TO ON. CHECK FOR +26V DC AT A6P2-21 OR A6P3-3.
WAS +26V DC OBTAINED ?
NO
TROUBLESHOOT ANT. ANCILLARY GROUP (SECT VIII).
YES
IS BRAKES MANUALLY RELEASED INDICATOR LIGHTED ?
NO
YES
SET +26V DC PRIMARY POWER CIRCUIT BREAKER TO TRIPPED. INSTALL ANTENNA POSITION AND STATUS PANEL CIRCUIT CARD ASSEMBLY A6 ON EXTENDER CARD, THEN SET CIRCUIT BREAKER TO ON. CHECK FOR +26V DC AT A6P2-13 OR A6P2-19.
WAS +26V DC OBTAINED ?
NO
CHECK FOR 26 VDC AT TB4-13 ON AZ OR EL ELECT. CONT. AMPLIFIER
WAS -26V DC OBTAINED ?
NO
TROUBLESHOOT ANTENNA ANCILLARY GROUP (SECT VIII).
YES
TROUBLESHOOT AZ OR EL ELECTRONIC CONTROL AMPLIFIER
IS POWER FAILURE INDICATOR LIGHTED ?
NO
YES
SET ALL PRIMARY POWER CIRCUIT BREAKERS TO TRIPPED.
WAS ALL VOLTAGES OBTAINED ?
YES

Figure FO-12. Servo and control [illegible] troubleshooting [illegible]
(Sheet 2 of 3)

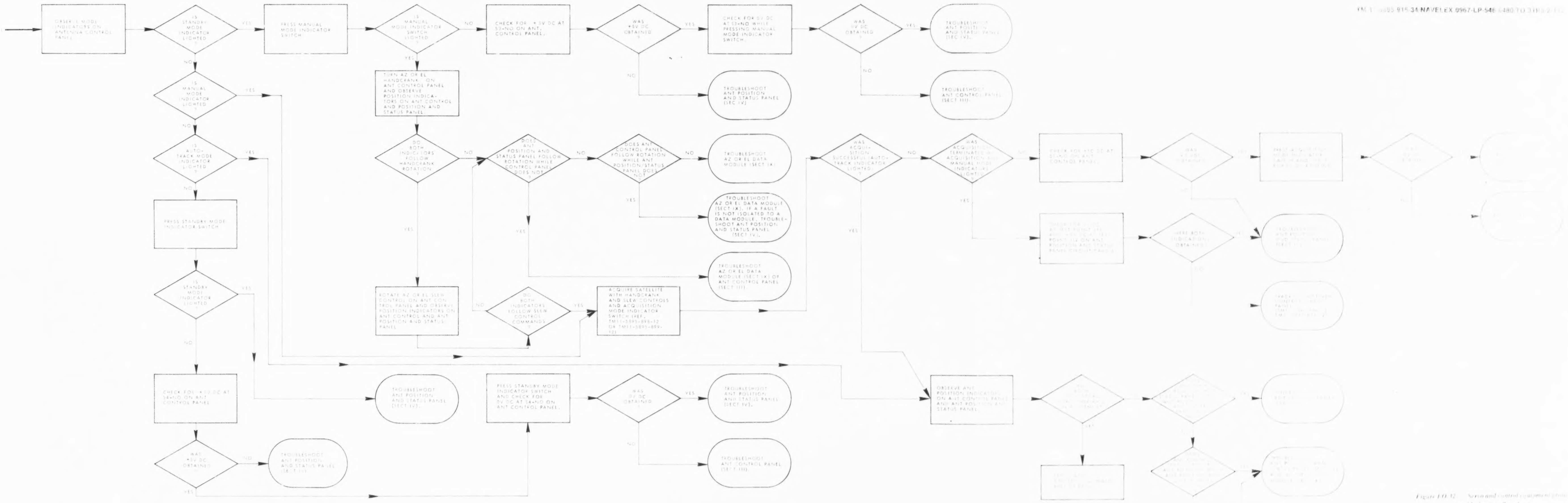

SHEET 1
OBSERVE MODE INDICATORS ON ANTENNA CONTROL PANEL.
IS STANDBY MODE INDICATOR LIGHTED ?
YES
NO
PRESS MANUAL MODE INDICATOR SWITCH.
IS MANUAL MODE INDICATOR SWITCH LIGHTED ?
CHECK FOR +5V DC AT S3-NO ON ANT. CONTROL PANEL.
WAS +5V DC OBTAINED ?
CHECK FOR 0V DC AT S3-NO WHILE PRESSING MANUAL MODE INDICATOR SWITCH.
WAS 0V DC OBTAINED ?
TROUBLESHOOT ANT POSITION AND STATUS PANEL (SEC IV).
TROUBLESHOOT ANT POSITION AND STATUS PANEL (SEC IV).
TROUBLESHOOT ANT CONTROL PANEL (SECT III).
IS MANUAL MODE INDICATOR LIGHTED ?
TURN AZ OR EL HANDCRANK ON ANT CONTROL PANEL AND OBSERVE POSITION INDICATORS ON ANT CONTROL AND POSITION AND STATUS PANEL.
IS AUTO-TRACK MODE INDICATOR LIGHTED ?
DO BOTH INDICATORS FOLLOW HANDCRANK ROTATION ?
DOES ANT POSITION AND STATUS PANEL FOLLOW ROTATION WHILE CONTROL PANEL DOES NOT ?
DOES ANT CONTROL PANEL FOLLOW ROTATION WHILE ANT POSITION/STATUS PANEL DOES NOT ?
TROUBLESHOOT AZ OR EL DATA MODULE (SECT IX).
TROUBLESHOOT AZ OR EL DATA MODULE (SECT IX). IF A FAULT IS NOT ISOLATED TO A DATA MODULE, TROUBLESHOOT ANT POSITION AND STATUS PANEL (SECT IV).
TROUBLESHOOT AZ OR EL DATA MODULE (SECT IX) OR ANT CONTROL PANEL (SECT III).
WAS ACQUISITION SUCCESSFUL (AUTO-TRACK INDICATOR LIGHTED) ?
WAS ACQUISITION TERMINATED IN ACQUISITION AND MANUAL MODE INDICATORS LIGHTED ?
PRESS STANDBY MODE INDICATOR SWITCH
IS STANDBY MODE INDICATOR LIGHTED ?
ROTATE AZ OR EL SLEW CONTROL ON ANT CONTROL PANEL AND OBSERVE POSITION INDICATORS ON ANT CONTROL AND ANT POSITION AND STATUS PANEL.
DO BOTH INDICATORS FOLLOW SLEW CONTROL COMMANDS ?
ACQUIRE SATELLITE WITH HANDCRANK AND SLEW CONTROLS AND ACQUISITION MODE INDICATOR SWITCH (REF. TM11-5895-898-12 OR TM11-5895-899-12).
CHECK FOR +5V DC AT S4-NO ON ANT CONTROL PANEL.
TROUBLESHOOT ANT POSITION AND STATUS PANEL (SECT IV).
PRESS STANDBY MODE INDICATOR SWITCH AND CHECK FOR 0V DC AT S4-NO ON ANT CONTROL PANEL.
WAS 0V DC OBTAINED ?
TROUBLESHOOT ANT POSITION AND STATUS PANEL (SECT IV).
WAS +5V DC OBTAINED ?
TROUBLESHOOT ANT POSITION AND STATUS PANEL (SECT IV).
TROUBLESHOOT ANT CONTROL PANEL (SECT III).
WERE BOTH INDICATIONS OBTAINED ?
OBSERVE ANT POSITION INDICATORS ON ANT CONTROL PANEL AND ANT POSITION AND STATUS PANEL.

Figure FO-12. Servo and control equipment group troubleshooting flowchart (sheet 1 of 3)